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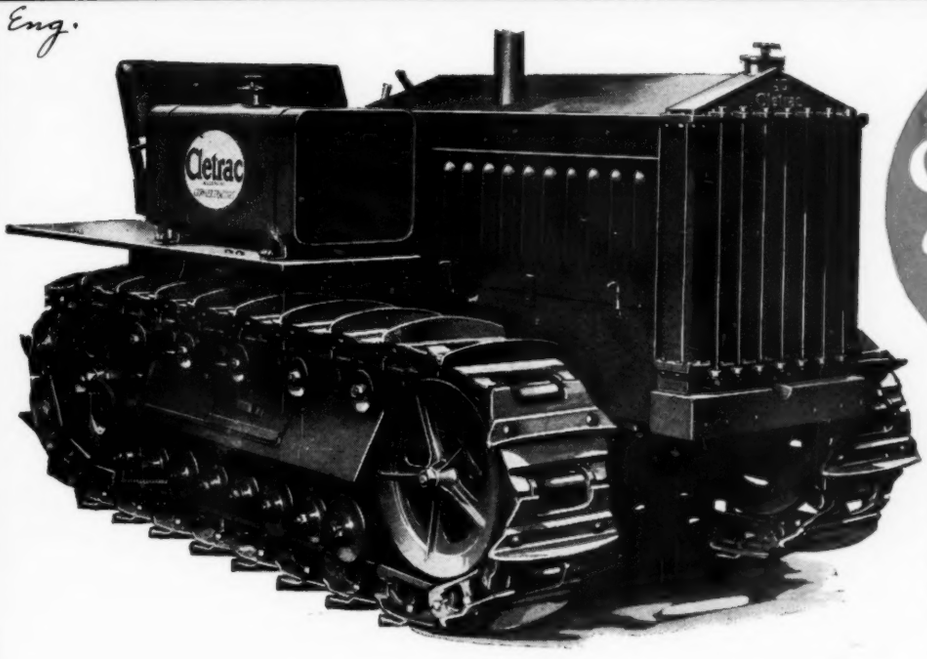

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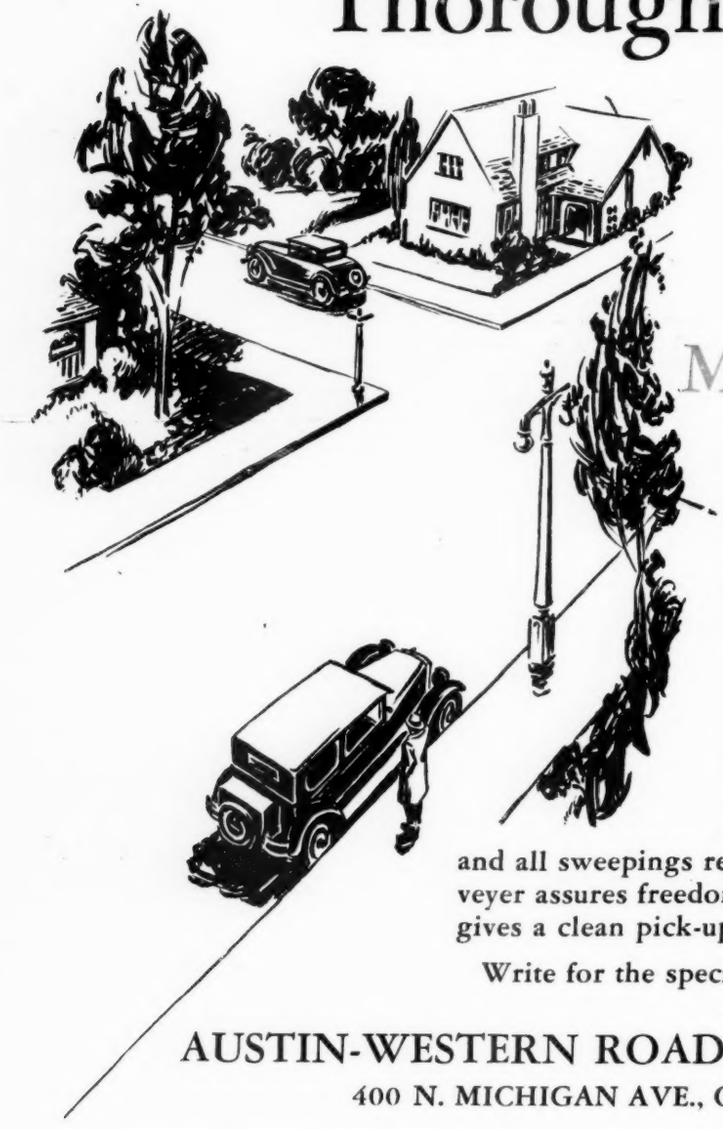

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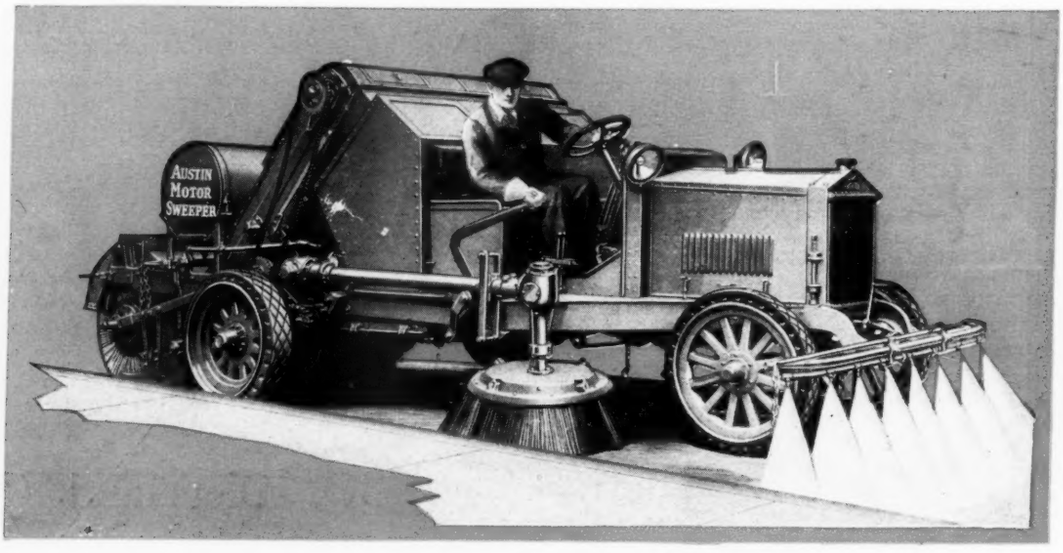

"MOST MILES FOR YOUR ROAD DOLLARS"

VOL. 59 NO. 3

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CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 59 March, 1928 No. 3

Pavement Widening in Niles

How city utilized, for automobile parking, sidewalk space six to twelve feet wide which had formerly been occupied by grass, trees, poles and fire hydrants

By Vernon N. Taggett*

Modern traffic has brought to engineers of average-size municipalities the problem of providing traffic ways and parking places or terminal facilities for the privately owned and operated autos, public taxis and buses and commercial trucks.

The movement of traffic expeditiously and safely has been of the first importance and has, therefore, received very general consideration in every section of the country, as witnessed by the development of arterial streets and thorofares and the development of various signs, signals, directional towers, flashers, reflectors and other helps and hindrances that we find in our various municipalities. The multiplicity of these traffic aids and impediments bear testimony to the recognized problem and are, to say the least, evidence of the resourcefulness of the American manufacturer. I doubt if there is a village or city anywhere in the United States, that does not have stored away somewhere out of sight, in a place where they hope that the tax payer will never see them again, numerous so-called traffic guides or signals, many of which were purchased from a glib-tongued salesman after he had hypnotized the town council. But many very efficient aids have been brought out which are now accepted as standards, such as the automatic stop-and-go signals, the traffic lanes as marked on pavements, and automatic flashing red lights.

THE PARKING PROBLEM

The other phase of the problem is the question of the parked automobile. It is very desirable that municipalities make it easy for people to visit our stores and offices for the transaction of business. Under most conditions it is well to provide opportunity for short-time parking, but under no conditions should the public streets be used as storage places for autos to the inconvenience of traffic.

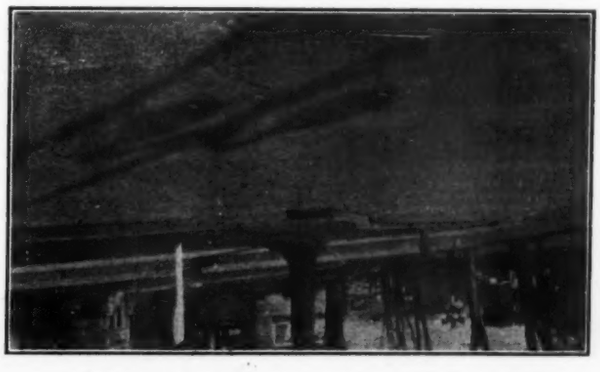
There appears to be no cure-all for our parking problem, a sample of which enterprising salesmen can load into their automobiles and carry to municipalities, as is done with traffic buttons, warts, flashers, etc. The solution of the problem is so different from that of moving traffic that it remains for each local community to handle the problem from within. The writer has undertaken to tell in the following paragraphs how he is attempting to solve problems arising in the city of Niles, Michigan.

The principal business street in Niles, Michigan, is eighty-two and one-half feet wide with the entire width occupied by pavement and sidewalks. Most of the intersecting streets, however, are only sixty-six feet wide with a grass plot on each side of the pavement and extending from the curb line to the outer edge of the sidewalk. This strip is occupied by pole lines, fire hydrants, and in many places by trees. As the city has grown, what was once a purely residential street is becoming business territory. Homes are being replaced by business blocks. This brought increased traffic and it became necessary to prohibit all parking upon one side of the existing twenty-six foot pavement.

This was not satisfactory, of course. The logical procedure would have been the inauguration of a

* City engineer of Niles, Mich.

RAISED WALL TO KEEP CARS OFF SIDEWALK



OLD CURB INLET AND NEW FLAT INLET

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MARCH, 1928

pavement widening program. However, the administration, as is often the case, was handicapped by the lack of necessary funds. Special assessments were considered, but it appeared that owners of property not as yet occupied by business places were not in favor of expenditures for improvements that were of little or no benefit to their own property, although necessary for their neighbors. The city's budget could not be conveniently stretched to include funds to provide for all of the pavement widening that was desirable.

HOW NILES WIDENED STREETS

In the face of these conditions, the owners of the improved business property were glad, with the approval of the city, to widen the pavement along their own property. The city has each year, for the last three years, been able to release limited funds from its general budget in order to widen the pavement at other important locations where it was plainly evident that the particular piece of property would receive no special benefit.

On the streets where the pavement has been widened, the curb has been five or six inches in height and the slope from the walk to the top of the curb has been from nothing to three inches. In all widening that we have done we have left the street drainage about as it was, changing only the style of inlets from the curb grates to the flat grates.

The first year, two jobs were completed and in each case the new portion of the pavement was sloped upward from the old gutter line to meet the sidewalk. This afforded excellent drainage of the new section of pavement but did not provide any means of keeping autos from parking upon the sidewalk. In fact, careless drivers such as depend upon the curb acting as a brake sometimes permitted their cars to bump against the adjacent buildings. In order to remedy this condition, sections of concrete curb eight inches high and six inches wide were constructed along the outer sidewalk line. At frequent intervals short sections of the curb were omitted for the convenience of people going to and from their cars, and also for providing the necessary drainage from the walk to the gutter.

Since the first year, we have aimed to keep at least a five-inch or preferably a six or seven-inch drop at the new curb from the present sidewalk to the new pavement. This necessitates a very flat cross slope on the new section of pavement.

We are now exercising extra care to maintain proper slope, in order that we may have no low spots to hold water after rains, sprinkling or flushing.

PAVEMENT WIDENED WITHOUT COSTRUCTING NEW CURB. NOTE CARS STANDING ON WALK

All of these sections of pavement thus far have been constructed of concrete because of its economy. Both brick and sheet asphalt pavements have been widened by this method. Although there is a contrast between the concrete and the other types of pavements, we feel that the new work is usually looked upon as a parking space, or possibly an extra wide apron on a combined curb and gutter.

In this widening program we have been able to add from six to twelve feet at the side of the pavement, thus providing for paralled parking in the former case and angle parking in the latter. Also, by the increased width, buses are enabled to turn out of the line of traffic, while loading and discharging passengers.

Our work has proved very satisfactory. The only criticism has been that the city does not do enough of this work each year.

Trucking Sticky Material

Contractors have found that certain soils and clays when wet, although they pass through the bucket on the power excavating equippment without any great difficulty, when loaded into trucks and transported any distance settle down and adhere quite firmly to the sides of the truck and refuse to slide out when the body is put into dumping position but often have to be shovelled out by hand. The Ariss-Knapp Company, contractors, who have a contract for surfacing in Alameda County, California, have overcome this difficulty in a novel way. The inside of each truck body, before it receives its load of earth, is dusted over with rice hulls. These prevent the adhesion of the soil to the body of the truck and it discharges readily when the truck bed is raised. The hulls are a waste product of all California rice mills and may be secured for the trouble of hauling them away. Probably chaff or other similar materials can be found in other sections of the country to serve the same purpose.

Reinforcing Pavement Bases in Clinton

By Benton R. Anderson*

In Clinton, Iowa, the subgrades under our pavements vary from solid rock to a spongy fill. This wide variation of the bearing power of the subgrade is further complicated by sewer, water and gas main ditches, and services running to each lot, many of which are in new ditches, having been constructed to vacant lots in advance of the paving work.

Our pavements are designed on the principle that if a pavement can be kept up to the true grade it will be spared the destructive blows of heavy trucks. If a firm, unyielding subgrade to insure this is not found, it is provided in the contract and specifications that extra reinforcing steel and extra thickness of concrete may be used where needed. The inspector requires the contractor to keep a supply of 6-foot and 8-foot lengths of ¾-inch bars on hand on the job, and these are used over service ditches quite liberally. When any unusually spongy subgrade is found it is called to the attention of the engineer and he determines the extent of extra material to be used, in the form either of reinforcing, or of extra thickness, or both. Payment is made on

*City engineer, Clinton, Iowa.

the basis of weight of extra bars and cubic yards of concrete used.

On one job, over a filled-in culvert, a reinforced slab was constructed 12 inches thick and about 30 feet long and the full width of the pavement, which was 30 feet. In another place where the soil was naturally spongy and not filled ground, it was thought necessary to use 1-inch transverse bars spaced 24-inch centers across 30 feet of pavement and half-inch bars 24-inch centers longitudinally, for a distance of about 1,000 feet.

Special attention must be given to expansion joints where heavily reinforced concrete is used. It has been our experience with such work that where the standard design of concrete connects with the more heavily reinforced section, there will be a buckling if adequate expansion is not provided for. In using the extra reinforcing and the extra thickness of concrete, we work on the theory that all the pavement should be of about equal strength and durability.

With wide variations in the quality of the subgrade, the use of a standard design throughout would indicate that over the good subgrade the pavement is stronger than is necessary or else over the poor subgrade it is inadequate. Our aim is to change the design to fit the subgrade as it is found.

Below Zero Excavating

During the past winter S. M. and F. J. Feeley, contractors, of Denver, Colorado, have been carrying on excavating work under very low temperatures. They are digging a ditch 14 feet wide on the bottom with 1½ to 1 slopes and 7 miles long in broken-up granite rock at a point about 150 miles from Denver, 30 miles from the main line of the railroad, and at an elevation of 12,500 feet. At times the machine has been working with the mercury at 45° below zero, the snow ranging from 5 to 7 feet deep. During most of the winter the machine has been operated with double shift and averaged 770 cubic yards per 8-hour shift. The contractors are using an Osgood 1¼-yard heavy-duty gasoline shovel equipped with a Le Roi 4-cylinder motor. This is said to be the highest elevation and the lowest temperature yet reported at which a gasoline shovel has operated successfully.

Paving Progress in 1927

Wishing to summarize in this annual street paving issue the progress in the science and art of street paving which was made during the year 1927, we have asked paving engineering specialists to prepare articles covering that subject, each dealing with the kind of pavement with which he has had opportunity to become specially familiar. A brief outline is given of the main features of the professional experience of each, from which it will be seen that it would be difficult to find engineers more competent to prepare such reviews.

Only the four hard-surface pavements are included which have found widest use in paving city streets; and a general article dealing with various low-cost pavements which are used for minor-traffic streets. Reference to the tables of paving done will show the use made during the year of these and also of rock asphalt, asphalt block and other materials not included. Especially noticeable is the increased use of rock asphalt, not only in Kentucky and Texas but even up in New England.

Developments in the Art and Science of Asphalt Paving During 1927

By Francis P. Smith, Ph.B.*

NEW TYPES

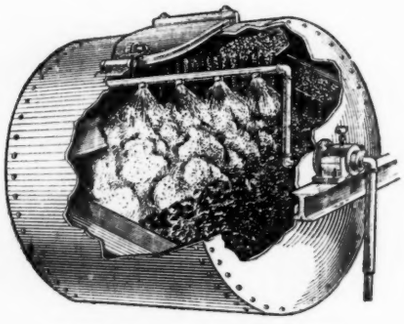
Asphalt Macadam. In the ordinary process of manufacturing asphalt macadam pavements, many of the stone particles of the aggregate are imperfectly coated with bitumen and some of them receive practically no coating at all. In order to remedy this defect, the three sizes of stone ordinarily used are coated at the quarry with about 2% of asphalt cement. This thinly coated stone is then shipped out and used in exactly the same way as in ordinary asphalt macadam construction. The slight coating of asphalt is not sufficient to bind the particles together to such an extent as would interfere with laying in the usual manner. After laying and rolling, the ordinary methods of applying asphalt by means of a pressure distributor are employed, reduction in the amount applied being made to compensate for the asphalt already on the stone. This method produces an asphalt macadam pavement in which every stone particle has received a coating of bitumen.

Cold Mixed Pavements. A type of cold mixed pavement which is also laid cold has been developed in which the aggregate is mixed with a hard, brittle bitumen in the powdered state, together with sufficient fluxing oil to eventually combine with the hard bitumen, making an asphalt cement of suitable consistency. The process of combination between the hard asphalt and flux takes place slowly and permits the spreading and finishing of the pavement without heating the mixture. The stability of

*Chemical and consulting paving engineer, New York City. Past chairman, Sheet Asphalt Specification committee of the Am. Soc. for Municipal Improvements; past chairman of Committee D, Am. Soc. for Testing Materials; past president, Asphalt Technologist Association; delegate from Asphalt Technologist Association to National Research Council; delegate to Third International Road Congress; associate editor of Am. Highway Engineers Hand Books. Member of Am. Inst. of Chemical Engineers, Am. Soc. of Civil Engineers, etc.

mixtures of this type seems to be superior to those manufactured by former methods and there also appears to be a difference in the character of the asphalt cement produced by the cold fluxing method as compared with that produced by heating the same constituents together in like proportions. This process has so far been developed largely in connection with bituminous concrete and Topeka type pavements rather than with pavements of the sheet asphalt type.

Another type of mixture has been developed along somewhat similar lines in which heated sand, pulverized gilsonite and flux are mixed together at a temperature below that which would be necessary in order to make a complete and rapid union between the flux and the gilsonite. This product is capable of being stored and shipped without excessive handling costs. Before being laid it is heated to a temperature sufficiently high to produce a complete



ROTARY TYPE OF MIXER

combination between the gilsonite and the flux and the resulting mixture is laid and handled in the same manner as ordinary sheet asphalt.

All three of the above types are patented.

METHODS OF MANUFACTURE

The rotary type of mixer for use in sheet asphalt and bituminous macadam pavements has been improved and is coming into wider use. This mixer consists of a revolving drum, the mineral aggregate being introduced through a trap door which is then closed and revolved for a sufficient length of time to effect complete mixing of the aggregate. Asphalt is introduced through a hollow trunnion connected with a manifold inside the drum. The asphalt is sprayed under 50 to 70 pounds pressure while the aggregate is agitated by the revolution of the drum. A very complete and uniform coating of the various particles of the mineral aggregate are secured in this way and considerable penetration of the asphalt into the interior of the particles results. The batches mixed are larger than those handled in the ordinary type of twin shaft pug mill mixer, which tends to increase the uniformity of the pavement as laid.

METHODS OF LAYING

There appears to be a marked tendency to replace former methods of hand raking and distribution of hot mixture on the street by mechanical spreaders and finishers. These spreaders operate on steel curbs properly aligned and securely fastened to the subgrade. They are usually drawn back and forth by means of caterpillar tractors and/or rollers and have the great advantage of avoiding trampling and the resulting partial compression of the mixture during spreading. This tends toward maintaining uniform density in the hot mixture as spread and aids very greatly in producing a uniform surface free from depressions in the finished pavement. Such machines have been used in the South on some Federal aid projects and also in California.

RESEARCH AND CONTROL METHODS

A very considerable amount of research has been conducted during the past year on mineral aggregates, more especially those used in sheet asphalt pavement. The exact relation between the kind and grading of the mineral aggregate and the amount and consistency of the asphalt cement and the stability of the finished mixture, is far from being completely understood but much progress is being made in this direction. A number of methods are being developed for testing the stability (resistance to displacement) of the finished mixture and these meth-

MECHANICAL SPREADER AND FINISHER

ods are being applied to carefully controlled mixtures in which the different ingredients are varied both as to kind, proportion and size. The stability test has also been suggested as a means of controlling the output of paving plants. Further development of this research work will aid greatly in the design of mixtures for pavements carrying excessively heavy traffic and may result in the development of a different and possibly less expensive type for carrying secondary traffic.

SPECIFICATIONS

No marked changes in asphalt specifications, generally, have been made during the past year. In a few instances clauses have been inserted limiting the viscosity of the asphalt cement at mixing temperatures (350°F). In some cases the maximum viscosity has been limited on the theory that the lower the viscosity the more complete and uniform would be the distribution of the bitumen over the particles of the mineral aggregate under given mixing conditions. In other instances the minimum viscosity has been limited in an attempt to reduce feather cracking in the hot mixture under the roller. These two clauses are in direct opposition to each other and at present operate chiefly to restrict the kind of asphalt admitted under specifications containing them. It is possible, however, that some relation between viscosity and mixing and laying temperatures may be worked out which will be of practical benefit.

A limitation of the number of square yards of asphalt permitted to be laid by one gang and based upon the width of the roadway has been proposed. With a comparatively narrow roadway it is impossible to obtain satisfactory spreading and compression with an excessively large daily yardage.

NEW KINDS OF ASPHALT

With the diminution in the production of the Mexican oil fields and the development of large production in South America it is evident that sooner or later asphalts from South American crude will be placed upon the market. Considerable research work and experimentation is being carried on in connection with refining methods to be used with these crudes.

Progress in Brick Paving Practice in 1927

By John M. Egan, C.E.*

Very little change was made in the methods of laying brick pavements during 1927. Some minor changes in specifications were considered by various committees, but no definite recommendation has been forthcoming thus far. Change in methods of specifications are not frequent with regard to paving brick inasmuch as the material is one that has been used constantly for over 50 years, and procedure is fairly definitely established.

During the year there was perhaps more brick surface laid on rolled stone bases than previously. This was due to tests completed the previous year by the United States Bureau of Public Roads, which, after exhaustive test and a comprehensive survey of existing roads and streets which had previously been built, approved the practice of using non-rigid bases where soil and climate are favorable. Particularly in the South, the surfacing of non-rigid bases and even the surfacing of certain natural earths with paving brick received added impetus.

Practically all the paving brick laid in the United States continues to be laid with asphalt filler. This practice was recommended several years ago by the National Paving Brick Manufacturers Association, and each year proves the wisdom of that recommendation. Where brick is asphalt-filled, there is adequate room for expansion and contraction due to changes in temperature and moisture condition. The use of asphalt filler serves another useful purpose in that it deadens sound of the few remaining steel-tired vehicles which are in use. In a few instances the use of cement-grout filler has been noted during the year, but these cases are relatively scarce.

As to the sand cushion, the United States Bureau of Public Roads in their experiments proved that there was less breakage of brick under traffic when laid on a straight sand cushion, as compared with brick laid on a cement-sand cushion.

Numerous instances of relaid veteran brick pavements were reported during 1927. Pavements which had been in use for more than 30 years, and in many cases laid on totally inadequate bases, were renewed by removing the brick, preparing the bases and relaying the brick with the unused side turned up to receive the traffic.

An increasing number of jobs were reported during the year in which pavements which had become worn and in need of repair were resurfaced with vitrified paving brick. This resurfacing was carried out on various types of pavements, such as asphalt, concrete and other types less common.

In the matter of research, the outstanding accomplishment was the appointment of an engineering commission under the chairmanship of William M. Connell, past-president of the American Road Builders Association, which commission is at present investigating all types of pavement construction in a fair and impartial manner with the purpose of developing data on the life and maintenance cost of paving material. When this survey has been completed it will add valuable data on this important phase of road and street work.

*Chief engineer, Midwest Paving Brick Manufacturers Association.

Granite Block Pavements During 1927

By Clarence D. Pollock*

During the year 1927 granite block pavements continued their normal use and in addition a new field continued to develop. This was the increasing use of shallow granite blocks in the paving of bridges. Four-inch depth blocks had been used on many short bridges for a long time, but in 1924 a block 3½ inches deep was used in paving Harvard bridge between the cities of Boston and Cambridge, Massachusetts. This was an old steel girder cantilever type of bridge, having great vibration under traffic. The bridge was reconstructed, substituting

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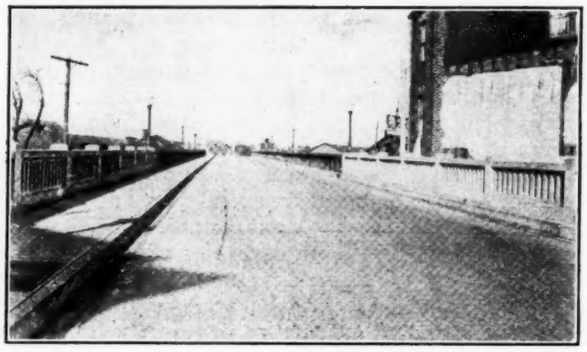

GRANITE BLOCK PAVING ON HILL-TO-HILL BRIDGE

steel stringers in place of the old timber ones, and then a deck six inches thick of planking was placed, on which a pavement of the shallow blocks was laid in a thin hot asphalt paving top mixture as a bed or cushion. The joints in the pavement were poured with hot asphalt cement.

Numerous pavements had been tried on this bridge, but due to the exposure to the weather and the very considerable vibration due to the traffic, none had proved at all satisfactory previous to the granite block pavement. This shallow granite block pavement is giving perfect satisfaction under the heavy traffic which passes over it and has not been injured by the great vibration in the bridge structure.

Since 1924 shallow granite blocks have been used upon a number of important bridges and bridge approaches such as the Hill-to-Hill bridge at Bethlehem, Pa., and the approaches to the Delaware River bridge between Philadelphia, Pa., and Camden, N. J. In both of these cases there are some pretty good grades, so that the granite not only serves as a very durable pavement under the heavy concentrated traffic, but also affords good traction under all weather conditions. Other recent examples of bridges thus paved are giving the best of satisfaction. A prominent example during 1927 was that of the Peace Bridge at Fort Erie, near Buffalo, connecting the United States with Canada, which was opened last Summer, a long and important link between the two countries.

On bridges having heavy traffic the vehicles must necessarily move in well defined lines and bridge pavements which will not rut under such traffic are becoming more and more necessary.

If a tunnel may be considered as a submerged bridge, another example is the Holland tunnel, the new vehicular tunnels under the Hudson river from New York to Jersey City. Here the traffic, similar to that on a bridge, moves in definite lines and therefor a granite block pavement was used, shallow blocks being used in order not to encroach on the headroom in the tunnels.

The shallow blocks are carefully made with smooth heads and such sides and ends that they can be paved with very close joints. In most cases an asphalt mastic joint filler has been used, and this is especially advisable rather than a cement grout joint filler if there is any appreciable vibration in the structure.

No changes have been made during the year in the standard specifications for granite block pavements of either the American Society for Municipal Improvements or the American Society for Testing Materials. Both societies had previously adopted an alternate standard specification for size of block, the only difference being in the width. The standard block had a width of 3½ to 4½ inches and the new alternate standard has a width of from 4½ to 5½ inches, the other dimensions remaining the same, which are from 8 to 12 inches in length and from 4¾ to 5¼ inches in depth.

Very recently the New Jersey State Highway Department has adopted a block having a width which partially overlaps these two standards—from 3¾ to 5 inches. This indicates a trend towards a wider block. The narrower block was the result of the days of horse-drawn traffic. With the better fillers in the joints today, there is no good reason for sticking to the narrow block.

Recent Developments in Concrete Pavement Construction

By H. Eltinge Breed, Sc.D.*

The most important developments during 1927 in concrete pavement construction are, I think, three:

1. Producing high early strength concrete to meet the demand for speedy opening of the pavement.

2. Using beam tests instead of laboratory compression tests to determine strength.

3. Constructing pavements laid to final grade by the sheet concrete method.

In order to eliminate the usual cause of dissatisfaction in the laying of concrete pavement—that is, the continued closing of the road to traffic from 14 to 21 days after it is apparently finished—specifications have been provided for two classes of concrete, with cement paid for as a separate unit. One specification provides concrete approximately of 1:2:3½ proportions, designed with proper workability so a limited water content could be used; other requirements are as usual. The other specifications provide for the same combination of aggregates, increase of cement content sometimes up to 33⅓%, increase of mixing time to 2½ minutes, commensurate decrease of water content, and the use of 2% admixture of calcium chloride as an accelerant, for which the contractor bids a separate price. The method of procedure is to increase the early strength of the last two days' run so as to be able to open a strip all at one time. Where intersections are encountered, half of the area is constructed of early strength concrete so as to cause only small delays. Under favorable conditions of temperature the pavement may be opened to traffic three days after laying and in others 4, 5 or 6 days. On work I did at Rye, New York,† while the 10-8-10 pavement was being laid, heavy truck traffic was permitted when a modulus of rup-

*Consulting engineer for highways and pavements, New York City. For two years assistant civil engineer with New York State Highway Department, and for four years chief engineer of the New York State Highway Commission in charge of all construction work. 1911-1912, acting chief engineer of the Coleman Dupont Road, Delaware. Member of Am. Soc. of Civil Engineers, Am. Concrete Inst., Am. Road B'ld'rs. Ass'n., Am. Soc. for Testing Materials, etc. Member of Structural Design Committee, Highway Research Bureau, National Research Council. Director, Department of Highway Engineering, New York University. Former chairman, special committee on Standard Construction Contracts, Am. Soc. of Civil Engineers.

†John A. Ehler, village engineer.

ture of 450 lbs. was secured; when a modulus of 350 lbs. was secured, medium trucks and busses were allowed to use the pavement; and when a modulus of only 250 lbs. was secured, light trucks and busses were permitted. In some cases abutting owners were allowed to take their cars in and out after 24 hours.

Pennsylvania and some other states are being influenced by scientific accuracy to require that the opening of a road to traffic depend not upon an arbitrary time limit but upon a definite strength value in the concrete, determined by the modulus of rupture. This method has the advantage of testing the sample with the same kind of a load that the pavement carries and for which its thickness is designed. Moreover, the testing equipment is inexpensive and can be provided for roadside tests. The high and low values secured are more indicative than are those of the compressive tests of the strength of the concrete, as they vary very little from the average mean.§

SHEET CONCRETE

The use of the sheet concrete method of construction answers two objections to the concrete type of pavement for city work, namely, the inability to resurface or replace the wearing surface unless the whole structure is scrapped on account of the fact that raising of the grade precludes 2nd story work; and the idea that service cuts or openings weaken the strength of the structure. Sheet concrete provides a structure which can be resurfaced when worn or damaged in whole or in part, and which is not damaged by surface cuts. Over two years have been spent in the laying of demonstration sections of from 200 to 800 square yards in area in cities and on heavy traffic roads. Preceding this construction, tests were carried on to determine the adequacy of this type of pavement.

In character this pavement is a suitable concrete foundation, above which is placed a rich-mix fine-aggregate top, generally 2" deep, the two courses having incorporated between them an open mesh burlap to provide a cleavage or splitting plane should occasion arise when it is necessary to remove the top.

Skeptics who admit that concrete properly designed and controlled makes an excellent pavement, raise three questions about sheet concrete: (1) Will the top adhere to the base? (2) Can the surface be removed and replaced at reasonable cost? (3) Will such replacement become an integral part of the structure as far as use under traffic is concerned? In order to answer these questions tests have been conducted to show the amount of adhesion in three ways.

First by direct tension in the concrete with the fabric inserted. The values secured ran from 84 lbs. to 280 lbs. per sq. in., while the plain concrete broke at 414 lbs. per sq. in. The lower value in the sheet concrete was when fabric of very fine cheese cloth was inserted, while the higher was for an open mesh fabric, showing that the amount of adhesion desired can be approximated.

Second, by beam tests. Here the value obtained for plain concrete and for sheet concrete were as close as is usual between two specimens of the same class, every test showing that there was sufficient adhesion to insure rupture in tension with no sign of shear failure in the plane of the fabric, even when steel reinforcement of the usual pavement weight was used.

Third, by impact tests, using an air-driven sheet-pile driver carrying a 3" x 6" oak buffer block on the pavement. After 33 hours of 1380 blows per minute—enough to destroy a number of buffer blocks—no damage had resulted, and when the top was then scaled back to the area of impact it showed no loss of adhesion. The base was resurfaced after the top had been removed. This resurfacing was tested one month later without the slightest loosening of the top. The destructive effect of the test can be realized from the fact that the sheet-pile driving head used, when fitted with a 1¾" drill, will drive it into solid lead 17" in sixty seconds .

The top can be removed with a bull point and a 16 lb. sledge, or can more readily be taken off at a low cost with a paving breaker fitted with a chisel point. One of the demonstration sections outside of Buffalo has had its top removed and replaced with no evidence of loosening under traffic.

OTHER IMPROVEMENTS

In addition to these major changes, there have come modifications of former practice, whose cumulative effect will be better pavements at lower cost. Many of these are due to clear-headed, persistent research in laboratories and in the field by various state highway departments and by material organizations. These are now giving us definite, detailed information that eliminates guess work, precludes "chances" and "luck" as factors, banish forever the old trial-and-error methods, and render inexcusable the repetition of a single failure, since it is possible to ascertain the cause of the failure and prevent its recurrence. Every engineer with a professional attitude keeps himself informed on the sources of information, and uses them to improve his work. The past year has been rich in the published results of research work.

These researches have led to wide adoption of the water-cement ratio; that is, accurate measuring of water in proportion to the cement used, so as to gain strength by using as stiff a mix as is workable.

They stress the importance of making correction for the bulking of sand. The surest method for this, used in Iowa and a few other states, is to correct by weight proportions.

They have resulted in New York State in a change in specifications from one minute of mixing to one and a quarter minutes.

On the mechanical side, there is general improvement in the quality of the cement furnished by the mills. Whereas the specification on one of my jobs required 78% of the cement to pass the 200 mesh sieve, there actually passed through it an average of 84% of all the cement used.

In construction, building the road in lanes has proven such a boon to traffic that it is being generally adopted. When it was first introduced, bids on work specifying it increased from 20 to 25 percent, but now the technique of organizing the work to be done in two or more longitudinal strips has become so simple that there is practically no increase in cost.

§An article by H. S. Mattimore in the 1927 Proceedings of the American Society for Testing Materials, Volume II, Technical papers.

Two developments in the placing of the concrete both affect the size of the slab. One is the installing of planes of weakness which limit the contraction crack across the pavement to a straight line. The other is the use of a machine to install transverse and longitudinal joints in green concrete immediately after it has been placed and before final finish is secured. Its advantage is that the pavement may be laid full width and continuously with larger daily output, as there is no time lost waiting to place joint bulkheads.

Steel for beneficial effect is being used more and more. In cities the tendency is to prefer the mesh type, as it facilitates the making of necessary service cuts.

Lowering of construction cost has resulted from increased output. The mixer now generally used lays 27 cu. ft. instead of 21 as formerly. While two years ago, 150 cu. yds. in 10 hours was thought a good amount, the output rose this year to 325 cu. yds. in 10 hours, or at the rate of a mile of 6" concrete 18 ft. wide every 5½ days.

One experiment which is being more widely tried is the curing of the concrete by means of a protective coating of tar or asphalt. This has the double advantage of retaining the moisture and darkening the surface. New Jersey and California are using this method on part of their new work, and it has been tried on the Syracuse Test Road in New York with good results.

Another method of curing without the use of water is the addition of calcium chloride to the mix.

The main contributions of 1927 to concrete pavement construction, involving these details, are to make concrete more available for use in city paving, and to provide greater assurance that the taxpayers will get full value for money that is spent on concrete pavement.

Low Cost Pavements for City Streets

By C. N. Conner*

Except in small cities and towns of less than two or three thousand population and residential streets and park roads in larger cities, pavements low in first cost are not successful if we base our opinion on present practice in progressive communities. The research work of such organizations as the Bureau of Public Roads, various state highway departments, the American Association of State Highway Officials, some universities and the Highway Research Board has done much to improve and standardize rural highways. No such effort has been made to correlate and disseminate information concerning municipal paving, although the need is as great.

An immense amount of valuable data and conclusions could be drawn from studies of existing city pavements, specifications, construction and maintenance methods, costs and service conditions. Present practise, however, is largely the result of individual rather than collective experience, of promotion rather than studies of all factors. The average municipal official needs unbiased and impartial information on city pavements similar to that which state highway officials now have on rural pavements.

It is not unusual to find the streets of small towns in a less serviceable condition than the adjacent state highways, although in some states it is customary for the highway department to continue the paving of the state route through a town, thus giving it one street which is well paved and well maintained.

Not all types of surfacing used on rural highways are suitable for city streets or even the streets of small towns. Certain factors must be considered in connection with city streets which may not affect rural highways. Streets must frequently bear the loads of heavy trucks, shovels and similar equipment, because of building operations, installations of water, gas, sewer, electric mains and connections. Storm water must quickly reach the gutters, and pavement surfaces must be kept clean.

Frequent starting and stopping of vehicles introduce stresses in the immediate surface which result in surface displacement. Parking spaces, little used by moving traffic, may show an unsatisfactory surface condition in certain types of pavement.

Small town as a rule are not equipped with machinery and tools for making necessary repairs. Patrol maintenance is unusual, even in the larger cities. It may be more difficult to make repairs on town streets than on rural highways, although repairs may be necessary at more frequent intervals because of service cuts. For these reasons the problem of selecting a suitable type of pavement, even for a small town, is frequently and rightly met by selecting a more substantial surfacing than is required on a rural highway which carries the same number of vehicles.

Streets which are residential in character, which contain no car tracks, and those from which heavy trucks are excluded, may give adequate service when surfaced with a pavement which is low in first cost. Costs, however, vary greatly with local conditions, such as availability of local materials and price of labor, but in order to present types of low-cost surfacing, types are here considered whose average initial cost is $2.00 or less per square yard.

UNTREATED SURFACES OF GRAVEL, CHERT, SHALE AND SAND-CLAY

When available locally and within short-haul distance, these materials have been used for surfacing if funds were not available for a higher type. The best results are obtained if all of the aggregates pass a 1½ or 1-inch screen and contain a small amount of clay, less than 20 per cent. If larger-size material is permitted at all, it should be used only as a base course and be covered with at least 4 inches of the fine clean aggregate.

For town and city streets early compaction is desirable, and this requires a power roller and prohibits the long-time process which compaction by traffic requires. The materials are first spread on the

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prepared subgrade from dump boards or from trucks equipped with suitable spreading or dumping devices. They are then shaped with a road blade, harrowed and bladed again. The harrowing and blading are continued until a surface uniform in texture and contour is obtained. This process may be accompanied by sprinkling with water. Rolling is the final operation, although additional scarifying and machining may be necessary, followed by more rolling before an acceptable surface results.

The surface is maintained by light one-man bladers or drags. Watering is usually necessary in the summer time and during dry weather, but surface treatments with calcium chloride or bitumen may be more satisfactory unless water can be applied frequently and cheaply. The principal objections to these surfaces are dust, lost of surfacing, erosion, corrugations, pot holes and the necessity of constant maintenance. For city work they are usually built with a higher crown than for rural highways in order to secure a quick run off of storm water to the gutters. Their principal good points are low first cost, ease and speed of construction. Some of the best examples of this type are the gravel surfaces in Asbury Park and Bradley Beach, New Jersey.

BROKEN STONE AND LIME ROCK BASE

Broken stone bases for various types of bituminous surfacing have been and still are widely used. They are laid to various thicknesses but seldom less than 4 or 5 inches. Hard broken stone and slag surfaces are built according to standard specifications for broken stone base or macadam. Lime rock, marl and similiar materials, such as caliche, are laid by somewhat different methods than the harder stones.

Since this type is primarily a base course, the use of materials which show a comparatively high per cent of wear under the abrasion test may be tolerated. This may, in some localities, permit the use of limestones, sandstones, and granites which would not be suitable in a wearing course. The

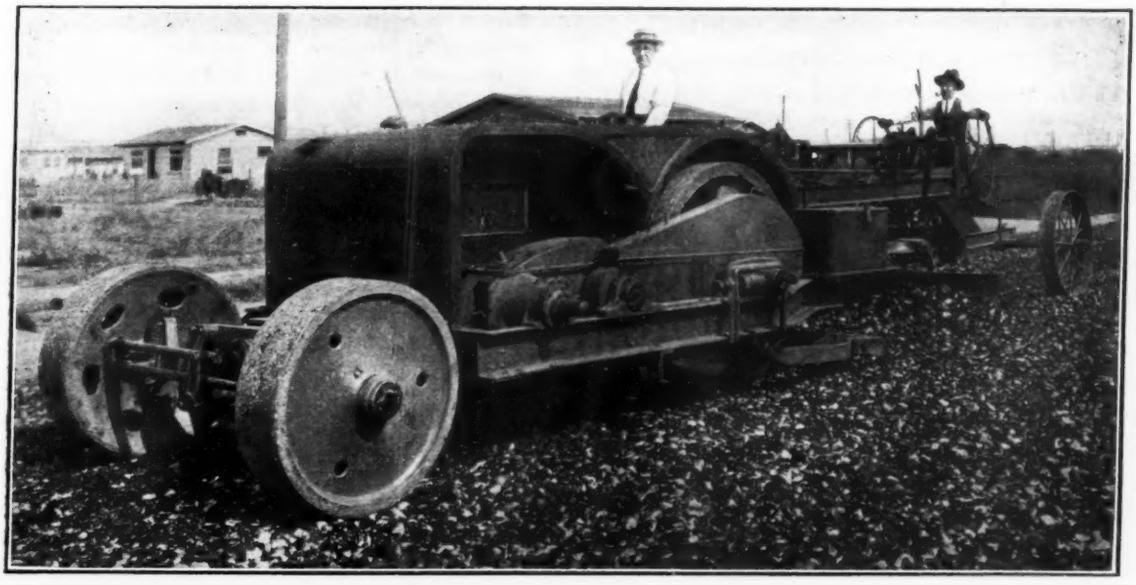
OILED ROAD. SURFACE BUILT UP OVER A PERIOD OF TWO OR MORE YEARS OF SUCCESSIVE APPLICATIONS OF LOCAL SAND-LOAM AND A COLD ROAD OIL

coarse stone in this case may be graded to pass the 4 or 3½-inch screen and be retained on the 2½-inch or 2-inch screen. The balance of the material, if not a commercial product, may be used as a subgrade treatment and the fines used as filler. If a commercial product, only the specified size need be purchased.

The bases of hard stone such as trap rock, limestone, granite and sand stone are built according to standard specifications for broken stone and water-bound macadam. The softer materials such as lime rock, marl and caliche are spread on the subgrade, sprinkled with water and rolled with a 10-ton roller. After thorough rolling and watering the surface is scarified, shaped with a road blader, rewatered and rolled again. This is continued until the entire depth is bonded and compacted.

These bases are left untreated for a period of several weeks in order that weak spots may be discovered and corrected before the surface course is placed. Dust may be reduced during this time by the application of calcium chloride or a prime coat of light asphaltic oil or tar.

As base courses for bituminous surface treatments and wearing courses, broken stone bases are still popular for residential streets and park roads in all parts of the country. Lime rock base is giving good service in serveral Florida cities, especially Miami. The principal objections to these bases are that they



RECONDITIONING OLD BITUMINOUS MACADAM BY SCARIFYING, BLADING, ROLLING AND RETREATING WITH BITUMEN AND STONE CHIPS.

do not always give a smooth riding surface, due to faulty construction or unequal settlement on subgrades of non-uniform bearing capacity.

Their good features include low first cost, use of local materials, and facility and quickness of repair after service cuts.

BITUMINOUS SURFACE TREATMENTS

There are two principal methods of thus treating city streets with bitumen applied from a distributor. The use of light oil treatments as dust layers is a temporary expedient and will not be considered here. The principal one for city work is the Penetration Method, but a new method known as the Mixed-in-Place is meeting with favor on rural highways.

The penetration method is used on well compacted, dense bases which do not have a loose surface. The bituminous materials are a cold bitumen for the first, or prime coat; generally a cold tar, a cut-back asphalt, or low viscosity road oil. The second application may be a second prime coat of the same bitumen. The seal coat is generally a heavier bitumen such as a hot asphalt, hot tar, a cold cut-back asphalt or a heavy road oil. The aggregates for cover material range all the way from a coarse, clean sand to ¾-inch stone or slag. Cover material should be hard and durable. Best practise calls for rolling with a power roller after the application of final cover, particularly if a hot bitumen and a coarse cover are used.

For light traffic this method of surfacing is giving good service. It must be renewed with light retreatments at periodic intervals of one, two or three years. In the course of time a surface of appreciable thickness, ¾ inch or more, is built up. This may become unstable and be displaced under traffic, but the condition may be corrected by scarifying, blading, adding crushed stone, rolling and topping with a light seal coat of bitumen and stone chips; followed by more rolling. These surfaces are seldom smoother than the base on which they are laid. They may become excessively rough if patches are improperly made or maintenance neglected.

THE MIXED-IN-PLACE METHOD

This is a method that is new, within three or four years. Its purpose is to consolidate the existing loose or unstable aggregates by mixing them on the road with bitumen. Surfaces containing such aggregates as crushed or screened gravel, stone and sand-clay or sand loam have been thus improved.

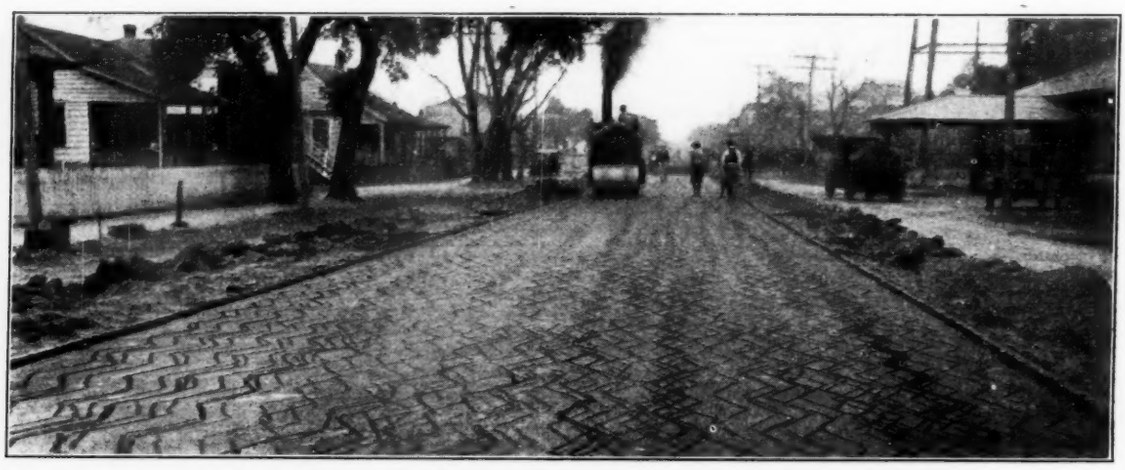
Either cold asphalt or tar have been used as bitumen. In a few instances both have been used. The bitumen should be such that it will not become sticky or "set up" until sufficient time has elapsed for the necessary manipulation of the mixture. The road oils which do not contain a solvent set up more slowly than the cut-back asphalts. They also leave a more plastic mixture. The surfaces which contain such aggregates as crushed or screened gravel and crushed stone have generally been selected for treatment. There is evidence, however, that poorer materials such as sand-clay may thus be sufficiently stabilized and their traffic capacity increased.

The construction methods are briefly listed below and are subject to some variations in different parts of the country. (1) Smooth the existing surface. (2) Scarify if necessary, harrow, machine and shape. (3) Apply first coat of cold bitumen and mix with harrow and road machine blade. (Sometimes harrowing is omitted. Blading is seldom omitted.) (4) Apply second coat of bitumen and mix thoroughly. (5) Sometimes a third coat is applied followed by more mixing. (6) Mixing is continued until a uniform color results. (7) Following a final shaping with a road blade or a drag, the surface preferably is rolled for final compaction with a power roller. Some engineers secure compaction by traffic. (8) A seal coat may be used if needed. An open surface may indicate this necessity or a lean base may be the indication.

Whether or not this type as used on rural highways may be adapted to residential streets has not yet been fully demonstrated. A method somewhat similar has been followed for some time over a long mileage in Long Island, New York.

PREMIXED BITUMINOUS TYPES

This class of surface treatment is in reality a thin surface course, as we have been accustomed to consider surface or wearing courses, such as bituminous concrete and sheet asphalt. By laying them thinner than standard practise or by using



CONSTRUCTING SAND-ASPHALT—ROLLING BASE COURSE
Base 3 inches. Top 2 inches of local sand, asphalt and filler

local materials, it is expected to secure a surface whose first cost is less than say $1.30 per square yard. Included in this classification are such hot mixes as sheet asphalt and bituminous concrete of the fine and coarse-aggregate types. The laid-cold surfaces are cold-patch bitumens, cut-back asphalts and road oils premixed with aggregates. Natural rock asphalts should be classed as a premixed type.

For the hot mixtures, standard specifications describe suitable bitumens and aggregates. The cold mixtures for surfacing are newer. Specifications for them are not as well standardized as a whole. Some experimentation and a little usage indicate that there is a possibility of producing an "unnatural" or synthetic rock asphalt, that is, one which may have many of the characteristics of sand-rock asphalt.

If the applied surface mixture is to be less than about 1½ inches in thickness and the base is porous or semi-porous, then a prime coat of suitable cold asphalt or tar is recommended. A binder course of "black base" or a thin course of penetrated stone will add to the stability and assist in keying the top to the base. The construction of the top itself varies very little from methods found in standard specifications. They include proper dumping, spreading, raking, patching and rolling. Final compaction by rolling must be secured in less time for the hot mixes than for the cold. This class of surface treatment is generally maintained by patching with the same material as in the surface or by cold patch mixes.

The traffic capacity of these types on substantial bases has been estimated and counted as between 1000 and 2000 vehicles per day. Some are carrying more. This type of surfacing is not as smooth to ride over as those which include blading as a construction operation. The cold mixes have some apparent advantages over the hot mixes. This advantage is apparent principally during the construction period. There is less interruption to traffic, less expensive equipment is required, and cost of plant operation is reduced in the construction of cold mixes.

PORTLAND CEMENT CONCRETE

This type for suburban sections of larger cities is now competing with bituminous surfaces on broken stone and "black" base. Sections 5, 6, and 7 inches thick are used, with local aggregates of sand, of fine gravel as well as the mixtures which meet the generally accepted standards.

The control of cracking by planes of weakness (dummy joints) and bituminous filled joints, together with quick methods of curing are doing much to popularize cement concrete for this work. If some of the curing methods with a surface application of asphalt or tar are effective, a black or brown finished surface may be obtained simultaneously with the curing.

This article can call attention to only a few of the salient facts on low-cost paving for city streets. The subject is broad, and detailed conclusions should be made only on correlated data obtained from a wide survey of actual conditions and records. The evident need for this correlated data is a conclusion in itself.

Paving Practice in Cleveland*

Foundations on clay and sandy soils, respectively. Central mixed concrete preferred. Protecting subgrade. Resurfacing old block pavements

An 8-inch concrete foundation is considered necessary for heavy street traffic in Cleveland, and not less than 6-inch is used on a residential street. The "nominal mix" is 1 cement to 6 of dry aggregate, but the amount of aggregate used depends upon the grading of the aggregate and the workability desired. Allowance is made for the bulking effect of moisture in sand, and the amount of water is limited to 6½ gallons per sack of cement.

The strongest foundation, however, will break if the soil under it heaves unevenly. Heaving may be caused by capillary absorption of water by clay expanding the clay, or by the freezing of such water, or of water collected beneath the foundation. It is believed that a porous, well-drained, yet solid layer of material four to six inches thick below the concrete foundation will intercept the capillary water, act as an insulator to prevent frost from penetrating deeply into the clay, and help in distributing traffic loads when the clay subgrade is soft. Cleveland for the past two years has been using a four-inch layer of granulated slag as a porous layer beneath pavement foundations on clay subgrades. During 1926 seven miles of pavement were laid on the granulated slag cushion course, and in 1927 approximately 35 miles were so laid.

The cost of a cushion blanket course has been equal to that of about 1-inch of concrete foundation, and it probably adds more strength to the pavement than 1-inch of concrete would.

In the central and eastern portions of Cleveland, the subgrade is for the most part sand. In this area 5-inch grouted brick pavements without concrete foundations have been in satisfactory use for many years. In the extreme eastern and western portions of the city, the subgrades are lake bottom clays which contain considerable amount of thin, shaley particles, and apparently are not subject to any considerable amount of heaving. In the southeastern portion of the city, which is on high ground above the boundaries of the old lake, the subgrades are plastic glacial clays which have a much higher colloidal content than any of the others and absorb large amounts of water and heave considerably during the winter months and dry and shrink in summer.

In 1927 the mixing time for concrete was increased from 1 minute to 1½ minutes and the average strength of concrete cylinders 28 days old

*Abstract of an article by George B. Sowers, deputy commissioner, Division of Engineering and Construction, Cleveland, Ohio, in the "Cleveland Engineering," the monthly publication of the Cleveland Engineering Society.

taken from the concrete in 1927 was 3,200 pounds, as against 3,000 per square inch in 1926.

The use of concrete mixed in a central plant and hauled to the street in a wet condition is permitted provided the elapsed time is not more than 45 minutes. Central mixed concrete comes to the street in a very workable condition, with little or no separation of the aggregate or water, and shows a compressive strength 15 to 20% higher than the street-mixed concrete. This increased strength may be due in part to more accurate proportioning and in part to more thorough mixing.

The city last spring equipped a very complete paving material testing laboratory where hardness, abrasion, and strength tests are made of all pavement material. Cylinders are made from the concrete of every pavement and tested for strength at various ages. Cores are drilled from every pavement to determine the thickness and to test for strength. Approximately 1,800 cylinders and cores from the 55 miles of pavement built in 1927 have been tested in the 200,000-pound compression testing machine.

Inspections of older pavements show that there is considerable variation in the thickness of the concrete due to unevenness of the surface of the subgrade, which in turn was perhaps due to hauling construction material over the subgrade and the resulting rutting. To prevent this, the city has required, in nearly every pavement built in 1927, that the contractor provide a plank roadway over the finished subgrade and no concrete materials are piled on the subgrade. This plank roadway not only permits the contractor to work at times when the subgrades are wet but has resulted in a much more uniform thickness of concrete.

No continuous steel reinforcing is placed in the foundation concrete but steel bars are used to strengthen the concrete where trenches have been cut into the subgrade preceding the building of the pavement.

The designing of the street railway tracks and pavement is not subject to the approval of the city engineer. It is now the practice of the city to completely separate the roadway pavement from the street railway track construction, the separation being effected by means of thin boards, the edge of the city pavement being supported by a steel angle, and being thickened. This construction has proven very satisfactory, especially where the tracks have later been rebuilt.

The original pavement on many of the main throughfares was of stone blocks laid directly on the natural sand. These made a serviceable pavement but have become quite rough and it has been the city's practice in recent years to cover these old stone block pavements with approximately three inches of sheet asphalt pavement. This resurfacing can be made without seriously interfering with the use of the street and can be quickly and easily repaired when openings are made. The resurfacing of old brick pavements which have become rough has not proven very economical.

The city requires its paving contractors to guarantee that the pavements will remain in good condition for a period of years, three years in the case of stone, brick and concrete, and five years in those having an asphalt top. The city makes a final inspection of the pavement before the guarantee is released, this including the taking and testing of cores from the concrete.

The designing and constructing of pavements is performed by the Division of Engineering and Construction in the Department of Public Service. Robert Hoffman is commissioner of the Division, and Stanley H. Murdock is in charge of the construction of pavements and sewers.

A Snow Cleaning Problem

A subscriber has sent us the following problem in snow removal which has proved very interesting to the editorial staff and, thinking it may interest others also, we give it herewith.

During a heavy snow storm a group of men went out to remove the snow from a street. It was found that eight men could clean a block in 20 minutes, while five men required 60 minutes to clean a block of the same size. It is assumed that the rate of working, individual capacities of the men, snow, etc., were all uniform throughout the period. How long would it have taken four men to clean a block?

There is no "joker" in it, although a hasty consideration might give that impression.

New Mexico Paints Highway Equipment Red

The New Mexico State Highway Department has announced that all its equipment, including graders, trucks and tractors, will be painted a bright red. The reasons given for this choice of color are as follows:

First, equipment painted a bright red offers great visibility to motorists and therefore lessens the probability of accidents due to drivers running into pieces of road machinery. Second, by having all state road equipment of a uniform color, it is readily recognized and identified. Thievery of such equipment would be more hazardous and stolen equipment could be easily identified and quickly recovered.

As rapidly as pieces of equipment are brought into the state highway shops for repair, they will be painted the standard "highway red" before being returned to the job. In this way the painting of machinery will take place gradually and the possible inconvenience due to shortage of equipment will be minimized.

Gravel Hauling Data

On a recent graveling job on the Yellowstone Highway, about fifty miles north of Cheyenne, Wyo., the Tyler and Baker Construction Co., Cheyenne, operated ten 2-ton model SD International dump trucks. Gravel was placed to a depth of 7 inches and a width of 18 feet. Graveling progressed at the rate of 1,700 feet per day. The average haul from the pit was 3 miles, and the average daily run of the trucks was 140 miles, equivalent to about 23 round trips.

Separate Sludge Digestion

A study of separate sludge digestion has been made by Anthony J. Fischer, Dorr Sewage Research Fellow, Dept. of Sewage Disposal, New Jersey Agricultural Experiment Station, special investigations having been conducted at Antigo, Wis., and six other plants. Thorough study has been made of the problems of sludge heating and gas collection, difficulties encountered in starting tanks and in correcting those that were in poor condition, and figures of cost and operating data have been collected. The information so collected he will set forth in a series of articles to be published in PUBLIC WORKS. *The first of these deals with*

Sludge Heating and Gas Collection at Antigo, Wis.[1]

Anthony J. Fischer[2] and Frank K. Quimby[3]

The Antigo sewage treatment plant is of the separate sludge digestion type and consists of a grit chamber, bar screen, sedimentation tank, trickling filter, sludge digestion tank and sludge drying bed.

The plant was designed for an ultimate sewage flow of 900,000 gallons per day and a contributing population of 10,000 people. A week's test run in December, 1926, showed that the flow averaged about 605,000 g. p. d. The present contributing population is estimated to be about 5600. Except for a considerable amount of whey and washings from a local cheese factory, the sewage is domestic, fresh, from a separate system. (The cheese whey was removed August 1st, 1927, but the washings from the plant are still present.)

[1]Paper No. 60, Department of Sewage Disposal, N. J. Agricultural Experiment Station, New Brunswick, N. J.
[2]Dorr Sewage Research Fellow, Dept. of Sewage Disposal N. J. Agri. Experiment Sta.
[3]City engineer, Antigo, Wisconsin.

DESCRIPTION OF PLANT

The grid and screen chamber is divided into two channels, each two feet wide, with an effective

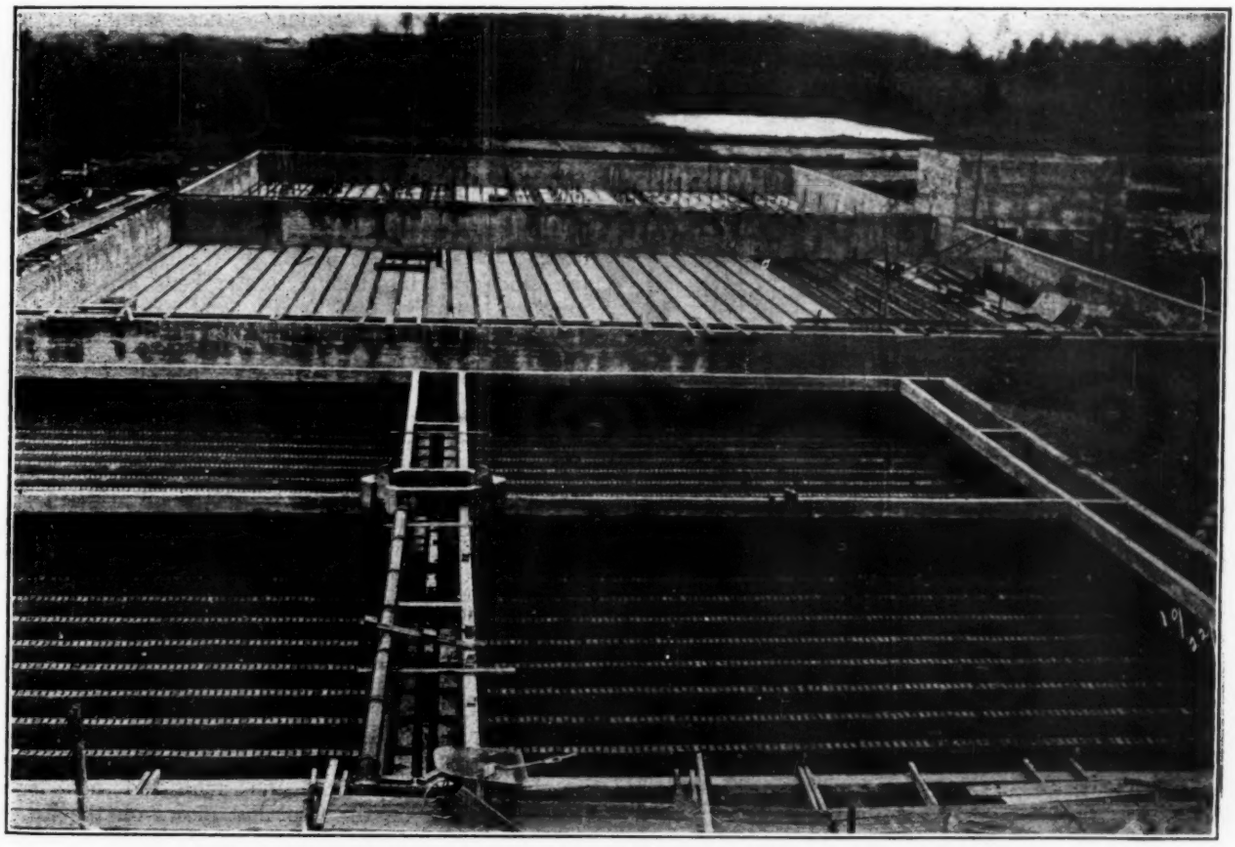


FIG. 1—ANTIGO SLUDGE BED AND FILTER BED UNDER CONSTRUCTION
Both sludge and filter beds are underdrained with Rawn tile. Drainage and aeration permitted by slots between vitrified brick. All concrete below air line is treated with asphalt to protect concrete from acid action. Sprinkler nozzles shown in far filter. Siphon chamber at right

length of about 16 feet. A bar screen set at a 45° slope, with clear openings of one inch, is set at the lower end of each channel, followed by suppressed weirs so adjusted as to give a velocity in the grit chamber of one foot per second at average flow.

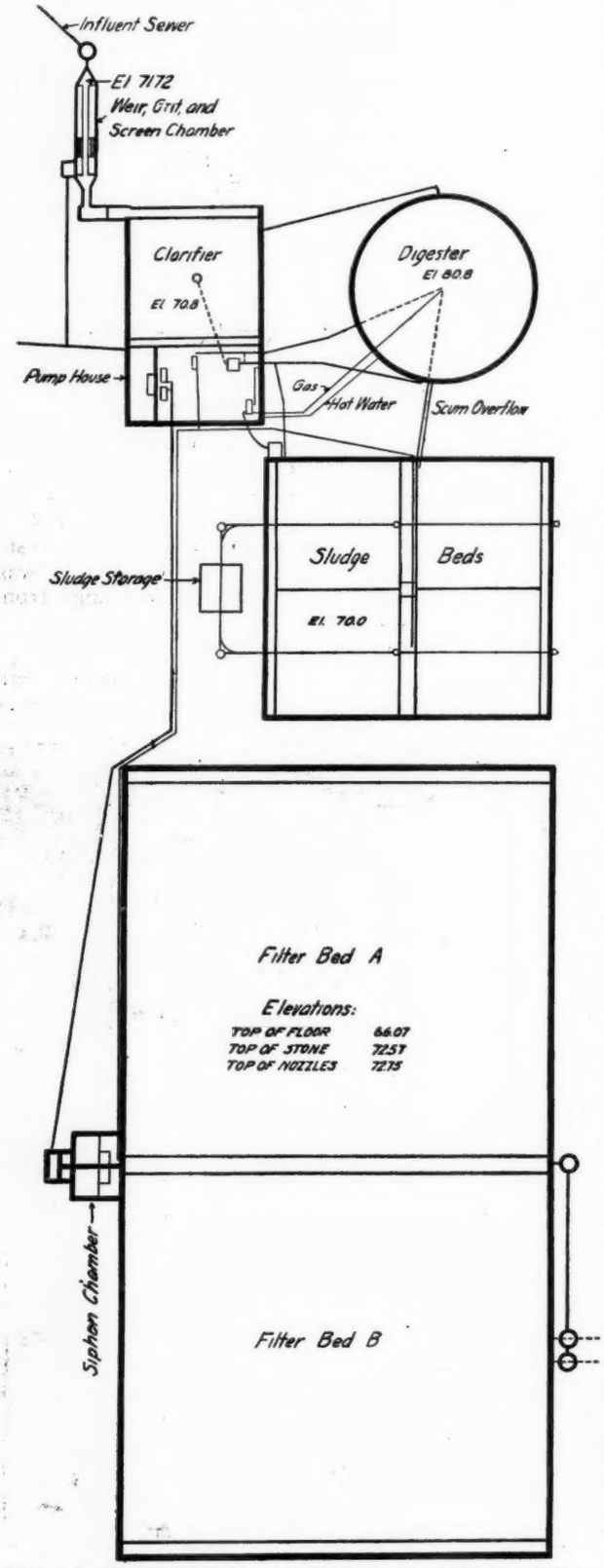


FIG. 2—CONSTRUCTION LAYOUT OF ANTIGO DISPOSAL PLANT

Both channels are underdrained for cleaning. Sluice gates at the upper end allow the use of either chamber or both.

The sewage is settled in a clarifier equipped with a Dorr mechanism. The tank is 35 feet square with a side water depth of 8 feet. The settling capacity of this tank is 75,000 gallons, giving a present average detention period of 3 hours.

The Dorr mechanism is operated continuously at a speed of about 1/12th r. p. m. and sweeps the settled sludge to a central cone, from which the fresh, raw sewage is pumped to the digestion tank by means of a 4" Dorrco pump of the pressure type. Ordinarily it requires about one hour's pumping each day to remove all the sludge with the pump delivering 40 gallons per minute*. Samples are taken from the pump every few days to determine the required time of pumping so that all the solids will be removed from the clarifier without any of raw sewage being pumped to the digester. The initial solid content of the sludge pumped is about 10 to 12 per cent.

The clarifier effulent may be by-passed directly to a nearby stream or may be run into a wet-well and pumped to a syphon chamber.

The syphon chamber is a twin unit, each syphon handling one filter bed and alternating the discharge between beds. The syphons are the Pacific Flush Tank Company's automatic trapless type.

The filter beds are 103 ft. by 117 ft. in area. They are filled with stone, varying in size from 1 to 3 inches, to an average depth of 6¼ feet and are drained by Rawn vitrified clay drains spaced 37 inches center to center. These drains empty into a channel between the two beds which carries the effluent to the stream. Inspection chambers are located at each end of the bed.

The digester is equipped with a Dorr digester mechanism, a sludge heating and a gas collection system, and has many new features from the standpoint of both design and operation.

An 8-inch pipe connects the center cone of the digester with a distributing box in the center of the sludge drying beds. These beds are four in number, each 35 feet square, and are drained by a floor system similar to that in the trickling filter beds. They are filled to a depth of 2 feet with stone varying in size from 3 inches to sand at the top. The drained liquor flows to a sump in the pump house, from which it is returned to the clarifier.

Digester. The digester is 50 feet in diameter and has a side water depth of 17 feet. The total capacity is 34,000 cu. ft. The sludge storage capacity (up to 18" below the overflow) is 28,000 cu. ft. or 2.8. cu. ft. per capita (design). The floor falls only 6 inches from the circumference to a small central cone. The roof slopes upward the same amount.

The roof is supported from the mechanism superstructure with clevises holding I-beams incased in the concrete beams cast monolithic with the roof slab. The Dorr mechanism is supported by the same superstructure and is similar to the clarifier mechanism except that the arms do not have squeeges scraping the floor but plows on the lower set of arms and held about 3 inches above the floor

*Last summer the rate of pumping was decreased to about 30 gallons per minute.

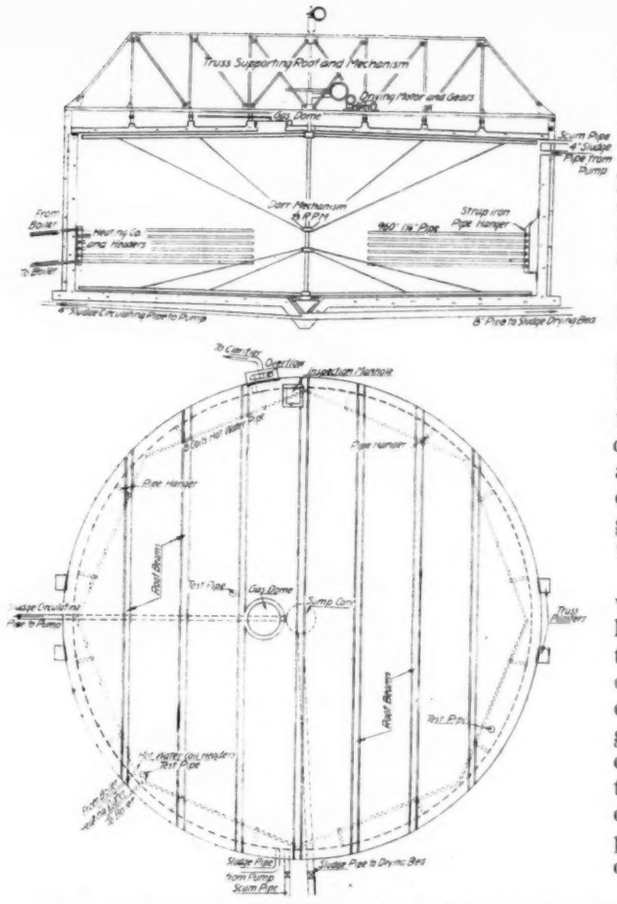


FIG. 3—PLAN AND VERTICAL SECTION OF DIGESTER.

cause the thick sludge to move toward the center of the tank. There are also two upper arms just under the roof which act as scum breakers. This mechanism is operated continuously at a speed of one twenty-fifth r. p. m.

A 4-inch sludge pipe enters the digester below the roof and diametrically opposite the overflow. The raw sludge from the clarifier is introduced through this pipe. A 4-inch pipe also connects the center cone of the digester to the sludge pump. By a suitable arrangement of valves it is possible to introduce raw sludge at the top or the bottom and to circulate the sludge in the digester from bottom to top by meaans of the sludge pump. This arrangement was found most useful during the first few months of operation when lime was being added to adjust the pH value of the digester contents. There is also a 4-inch line entering just below the roof to permit the withdrawal of scum if any should form.

The overflow which maintains the level of the liquid in the digester consists of two 6-inch pipes connecting with the inside of the digester 18-inches below the roof and extending upward to 18 inches above the under side of the roof, which point is the normal liquid level. These two pipes overflow into another pipe connected to the clarifier.

The test pipes and pipe seal around the mechanism shaft extend 3 inches below the under side of the roof and up to slightly above the maximum liquid level so as to prevent the escape of gas or liquid from the tank.

Gas Dome. Since the gas dome could not be placed at the center of the roof where the peak of the cone is located, part of the under side of the roof slab was cut away from the center shaft to the dome in order to make it at the highest point and to insure the absence of a gas pocket around the mechanism shaft.

The gas dome consists of a 3-foot circular opening in the roof slab surrounded by a concrete ring 2 inches higher than the normal liquid level. Inside this ring and resting on a shoulder in it is a steel dome, its bottom extending 7 inches below liquid level and its top 5 inches above such level. A pipe is connected to the top of this dome which carries the gas to the pump house. There is also a hand hole for cleaning and inspection.

Heating Apparatus. The gas collection and the water heating apparatus are located in the pump house. The gas contains a high percentage of moisture, which condenses and is caught in a trap made of 2-inch pipe. Next in line is an arrangement for cleaning out the line if it becomes plugged. The gas next enters a standard 10-light meter having a capacity of about 300 cu. ft. per hour. Normally the gas then passes into the safety flame trap, which consists of a sewer pipe sealed at the bottom and partly filled with water. At the top is a paper diaphram held between two machined iron rings,

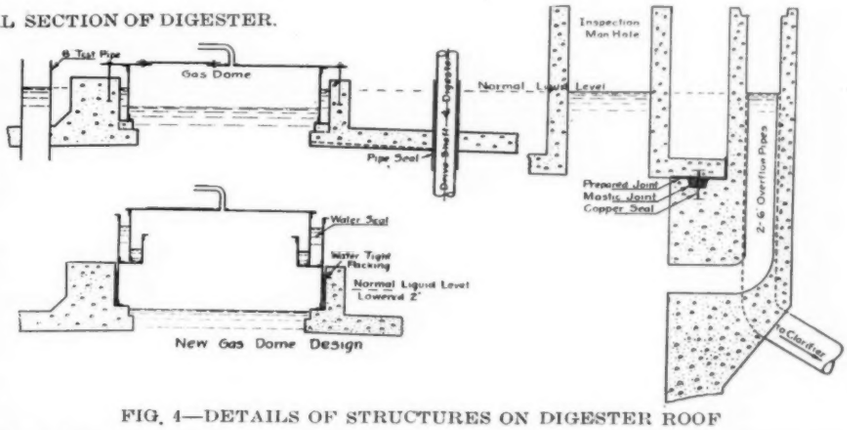


FIG. 4—DETAILS OF STRUCTURES ON DIGESTER ROOF

FIG. 5—HEATING COILS IN ACTIGO DIGESTER
Six coils made up of 2-inch galvanized pipe. All metal parts were painted with biturine.

the lower one of which is sealed into the bell of the pipe with soft asphalt. The gas enters this trap through a pipe which is submerged in the water about ½ inch. If for any reason the flame should back up from the burners, the water seal would prevent the flame from getting in the supply pipe and the gas would explode in the trap, blowing the paper off.

The gas is taken from the trap near the top, above the water line. A quick-action valve, next in line, is normally open and the gas goes to the Bryant heater, where it is burned in as many of the five burners as the supply warrants.

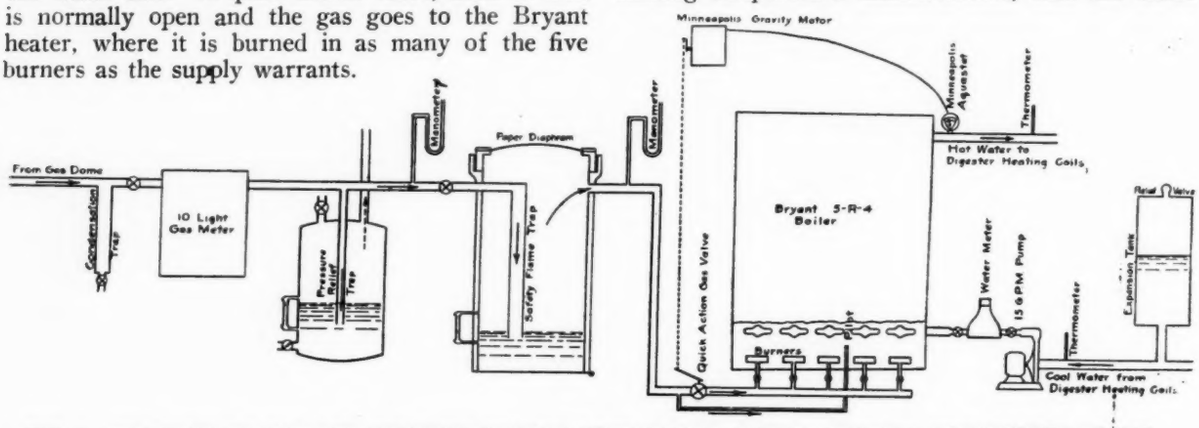


FIG. 6. DIAGRAM OF GAS AND HEATING WATER APPARATUS, ANTIGO SEWAGE TREATMENT PLANT

Pressure Relief Trap. If an excessive pressure is built up in the gas line, a pressure relief trap comes into play—a small hot water tank located between the meter and the flame trap with a pipe extending through the top down into the water and another from the top outside into the air. When the gas pressure exceeds the submergence of the entrance pipe, the gas escapes from this pipe into the tank and thence into the air.

Quick Action Valve. A quick-action valve, Minneapolis hydrostat and gravity motor safeguard the heater. If the power should give out, the small circulating pump in the heating line would stop and the temperature would rise in the boiler until the hydrostat, acting in the same manner as a house temperature regulator, would start the gravity motor and shut off the gas. This arrangement also prevents the circulation of water at too high a temperature in the sludge heating coils, and eliminates danger of sludge caking around the pipes. The pilot light gets its gas supply above the valve so that it is burning continuously and will again ignite the incoming gas if the temperature drops and the valve opens.

Heating Coil. The heating water leaves the top of the boiler, passes by the hydrostat and thermometer, then goes outside through an insulated pipe to the top of a 3-inch header in the digester. This header is connected to another one of like size by means of six coils of 1¼" wrought-iron pipes. The second header is connected to another length of insulated pipe, through which the return water flows back to the pump house through an expansion tank, past a thermometer, through a circulating pump and a water meter, back to the boiler.

The heating coil is arranged around the inside perimeter of the digester in eight sections of about 20 feet each, making a total of 960 feet for the six coils. The straight pipes are joined by a 45° elbows. These are supported about 1 to 6 inches from the wall. The pipes hangers are of heavy strap iron of the shape shown, with a pin supporting each pipe between the two straps. There are two hangers for each section of straight pipe. The lower pipe is 27 inches from the floor, and the pipes are 8 inches between centers.

When the digester was still empty, hot water was circulated through the coils and it was found, by making temperature measurements, that the distribution from the header to the pipes was not very good as the lower four pipes carried practically all the hot water. It is believed that better results would be obtained with a *continuous* helical coil. Here there would be no short-circuiting, as all the water would have to travel the entire pipe length.

OPERATION OF PLANT

Records. The plant was started in December, 1926. Since then fairly complete records have been kept. These records include temperature data, gas measurements and other physical data, along with such chemical determinations as pH values, total acidity, alkalinity, solids and ash.

Starting Digester. At the beginning of operation there was, of course, no gas that could be utilized for sludge heating, so a coal-fired steam heater which is now used for heating the pump room was connected temporarily to the heating coils. Coal was used as fuel until March 17th, when gas was burned using a crude burner in the same heater. This arrangement was replaced in June, when the present Bryant boiler was installed. This boiler is rated at 5 h. p., 62.5 sq. ft. heating surface.

Only five feet of raw sewage was run into the digester at the start, as it would have been difficult to raise the temperature of a full tank in a short time because of the severe weather conditions in this section during the winter months. Sludge and sewage was then added slowly, so that it took until February to fill the tank. In this way the temperature of the sludge was raised from 52° to 66° in two weeks. The latter temperature was easily maintained so that digestion processes were not impaired by the cold weather at starting. No ripe sludge was available to add as "seed."

Reaction Adjustment. The pH value of the digester contents was adjusted from the start by means of lime in the form of milk of lime obtained

by freshly slaking calicum oxide, applied when necessary through the manhole and test pipes in the roof of the tank. During the first three months 2435 pounds of lime as CaO was added. Since then the pH value of the sludge has remained about 7.4 to 7.6 and no further adjustment has been found necesary, in spite of the fact that considerable whey from the cheese waste was being introduced. From this it appears that, at least in small plants where there are facilities for heating sludge, the adjustment of reaction is necessary only during the first few months of plant operation.

Table 1 gives some pH values obtained in the liquid and sludge at various times. It will be seen that in the latter part of December the pH values at the bottom of the tank were extremely high while

Table 1. Giving pH Values in Liquid and Sludge at Various Times

Date	Liquid (5' down)	Sludge (bottom)
Dec. 7th, 1926	6.1	—
13	5.9	5.9
22	5.9	8.2
27	6.7	8.4
29	6.4	8.4
30	6.7	7.2
Jan. 3, 1927	6.6	6.8
15	6.3	6.8
Feb. 24	7.3	7.4
Mar. 10	7.8	7.8
Apr. 1	8.0	7.3
7	8.2	7.6
July 20	7.1	7.5
Aug. 31	7.2	7.5

those in the liquid were low. This was due to the settling action of the lime, which caused a thick alkaline sludge, consisting chiefly of lime, to settle to the bottom, while the top liquid was decidedly acid. Both these conditions are highly unfavorable for satisfactory digestion. Fortunately, the sludge in the digester could be circulated from bottom to top, so that a fairly uniform pH value was subsequently obtained. Without a circulating system of some kind, there is difficulty in adjusting the reaction and also danger of over liming, resulting in retardation of digestion and clogging of sludge lines with a thick lime sludge. The sludge was circulated from December 28th to March 5th, when it was discontinued as no lime was added after that date.

Advantages of Mechanism.—A unique feature of this digester is the almost complete absence of scum under normal operating conditions. This is undoubtedly due to the release of gas by the movement through the sludge of the arms of the stirring mechanism. When the mechanism is stopped, gas evolution falls off considerably, as the gas then adheres to the solid particles, causing them to float as scum at the liquid surface. The mechanism also allows the construction of a flat-bottomed tank, gives an equal distribution of raw sludge over the floor area and assists in the removal of digested sludge when it is drawn on to the drying beds. Tests have also showed that it gives an even temperature throughout the digester mass, and also insures an even gas evolution.

Difficulties.—A few days after the tank was started, scum appeared. This scum was gray in color, very light, full of gas, and was typical of material that floats during the first stage of digestion. This scum layer was present up to May 22nd, when it disappeared. The greatest thickness of the scum was 15 inches in the manhole at the side of the tank. The scum layer in the tank itself, however, was very thin at that time, as the upper arms of the mechanism swept the scum into the manhole, where it accumulated.

This floating material caused considerable difficulty with gas collection at the start, as it collected in the gas dome and clogged the pipe. Lately, the only material that collects in the dome is a light film of grease, along with such floating material as hair, leaves and sticks. This material is removed about every five days.

A scum rack consisting of a ⅛th inch mesh screen was placed in the gas dome at the start. This proved unsatisfactory and was removed because of clogging.

At present there is another difficulty with the gas collection system. The liquid level often drops, causing a breaking of the gas seal and escape of gas around the dome. The cause of this is believed to be the loss of liquid through the overflow. This liquid is possibly forced out by the rapid gas evolution.

Figure 4 shows the design of a new dome that will be installed. This dome has a separate seal independent of the liquid level, which would insure against the loss of gas around the dome should the digester liquid level drop for any reason.

In cold weather the water coming over with the gas often freezes in the gas line between the digester and the pump house and causes clogging. This can, of course, be overcome by better insulation.

COST DATA

The total cost of the plant excluding the stone for the trickling filters was $77,500. So far only one bed has been filled with stone at an additional cost of $8000.

The gas collecting system, consisting of dome, meter, traps and piping, cost approximately $150. The cost of the sludge heating system, including coils, boiler and piping, was between $1400 and $1500.

The total cost of operation for the year ending December 7th, 1927 exclusive of fixed charges was about $2000. This included labor, power and light, coal and lime. No repairs were necessary.

The power costs averaged about $30 per month for operating the clarifier and digester mechanisms, the sludge pump, fresh water pump, sump pump and heating water circulation pump.

20½ tons of coal were used for heating the digester contents and the pump house during the first winter. As the gas is now being utilized for sludge heating, this item will be greatly reduced, cutting operation costs considerably.

(To be continued)

Refuse Collection in Cincinnati

Beginning with July, 1926, the city council of Cincinnati, Ohio, provided for collecting household rubbish from the house line rather than from the curb line as had theretofore been the practice, and provided additional funds and personnel for this purpose. Some months later the council passed an

ordinance requiring all property owners to provide standardized metal cans with lids. "The advantages of this are many," said Fred Maag, superintendent of the Street Cleaning Department, in his annual report. "It relieves the unsightliness of trash in all kinds of boxes, baskets, and barrels scattered around the streets, and is a great help to prevent street littering. Furthermore it helps to keep the itinerant scavenger from scattering the contents in his pursuit of salvage, and it keeps papers and other trash from blowing onto and littering the streets."

The matter of dumps for rubbish also has received attention recently. Until within the past few years the city did not give dumps much attention outside of keeping the roadway clear so wagons could pass in and out. Now a special dump crew has been organized, and particular care is being given to leveling off the dumps and keeping them in better shape so far as appearance and tidiness are concerned. Numerous complaints have arisen because of indiscriminate dumping by outsiders of trash in any place that suited their convenience. The Department of Street, Sewer and Catch-basin Cleaning has endeavored to stop this by fencing in a number of the dumps, both to prevent indiscriminate dumping of rubbish by private parties and to prevent their being an eyesore to the immediate neighborhood. Most of the dumps are located in places where fills are desirable, and in reclaiming such land the city has increased values and thus has made the dumping a mutual benefit to both owners and city.

Mr. Maag's report gives the comparative costs of collecting by different kinds of vehicles. It is not stated whether these include overhead, etc., but at least it is probable that they are all computed on the same basis. Ash collection by wagons cost 84.7 cents per cubic yard; ash collection by tractors, 74c. and ash collection by trucks 64c. Collection of street sweepings by wagons costs 93.3c. per cubic yard, by tractors 84c. per cubic yard, and by trucks 53.9c.

Laying Sewer Pipe in Water

One excavating machine, traveling on parallel dock, used for trucking, laying forty-eight inch pipe and backfilling

The Edgewater plant of the Ohio Public Service Company is located on the shore of Lake Erie in Lorain, Ohio. The only two shutdowns of the plant during the past eight years have been on account of needle ice forming in the intake channel through which water is drawn from the lake for the condensers, which require 45,000 gallons of water per minute. This channel is 30 feet wide and 710 feet from the outer end to the screening house. It is formed by two parallel piers, the eastern pier supporting a railroad track on which a locomotive crane operates to remove the sand which continually washes into the channel during storms.

For several years the trouble with ice was overcome by discharging hot water from the plant into the inlet channel through a trench dug by hand each year. As the efficiency of the condenser is greatest when the water is coldest, it is desirable to heat it only enough to prevent formation of needle ice.

This use of hot water was found to be effective, but the hand-dug channel was crude and it was decided last year to lay a permanent conduit from the hot water outlet to the intake, this conduit to lie about 18 feet from the dock, mostly under water, and having a length of 512 feet. The sand was continually shifting and it would be impossible to keep open a trench for the pipe for very many hours after excavating.

A contract for the work was let to Trifiletti Brothers and the pipe was laid by them in the following manner:

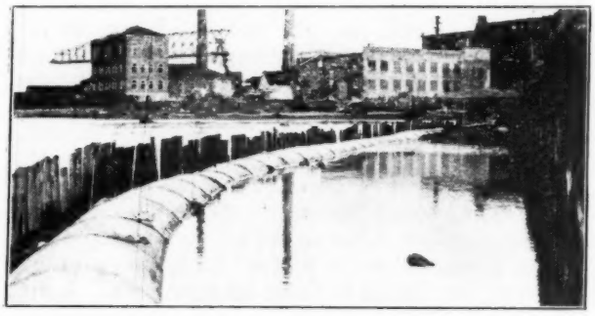
The dock is ten feet above water level, and, as stated, about 18 feet from the line of pipe. A Thew "back digger", travelling along the edge of the dock, was used for digging the trench, setting the pipe and backfilling over it, and even for driving the necessary piling.

As the work progressed, sheet piling was driven just outside the line of the pipe to protect the excavation from the washing sand, and sufficient length of trench was dug for two lengths of pipe. The digger boom then swung around and picked up a section of pipe by means of a pipe hook slung from the bucket, lowered it into place and held it in position until sand had been filled under and

EXCAVATING FOR ANOTHER LENGTH OF PIPE
End of pipe already laid shown in lower right hand corner

LAYING PIPE WITH HOOK SLUNG FROM DIGGER BUCKET

around it. The pipe used was double reinforced concrete, 48 inches diameter, 5½ inches thick, and 4 feet long, each length weighing about 1900 pounds. Two men with shoulder-high wading boots cemented the pipe on the inside at the bottom and on the outside at the top. Strips of cement bags were laid over the fresh cement to protect it from the wash of the water and from disturbance during the backfilling. After each section had been placed, the machine backfilled it before its postion could shift. It was necessary to make about a 45° bend in the line and this was made with a wide sweeping curve,



COMPLETED LINE OF PIPE, AND SHEET PILING DRIVEN DURING CONSTRUCTION

giving a slight angle to each joint.

At the hot water outlet of the plant, a box was constructed of slightly open piling, which stopped the flow of the hot water sufficiently to raise its level about ten inches. This gave head to force the water through the conduit and permitted sufficient cold water to mix with the hot so that its heating effect on the condenser water would not be too great. This piling as well as that along the outside of the pipe were driven by the back-digger boom, a railway tie being chained to the bottom of the bucket to be used as a hammer. The tilting bucket of the digger enabled the operator to control the position of the tie at any distance from the machine, which has a reach of 37½ feet.

Where the hot water line enters the intake channel, a cut was made through the original pier piling and a gate placed by a diver with a deep-sea diving outfit. This gate, which is five feet square, was made of two-by-fours bolted together, and slides in grooves of channel iron, being raised by means of a small windlass.

The contractor used five men and the back-digger for the job; the latter using about 25 gallons of gasoline and 1½ quarts of oil per day. About six yards bank measure of sand was removed per lineal foot of pipe. As most of it was taken from under water, the actual amount of material handled was more than twice that yardage. The job was started on October 15 and was completed in less than three weeks.

Street Lighting Practice

In a paper before the American Society for Municipal improvements entitled "Street Lighting and the Municipality," L. A. S. Wood manager of the Street Lighting Section of the Westinghouse Electric & Manufacturing Co., stated that, although a 1,000-lumen (100cp.) lamp provides barely sufficient light to mark streets but gives practically no illumination on them, 57 percent of the street series lamps sold during 1926 were of this size or smaller. In the opinion of the National Electric Light Association, "the 2500 lumen lamp is the smallest size which may be used with good economy."

Mr. Wood presented the accompanying table as representiing good modern practice for street lighting.

Providence Filtration Plant

First year's operation of plant. Aeration, coagulation, filtration and effluent areation

The City of Providence, R. I., put into operation on September 30, 1926, a filtration plant used for purifying water impounded in the Scituate reservoir. This reservoir has a storage capacity of about 37 billion gallons. The flow of the stream is used by a number of mills, and the city made a contract with these by which a continuous flow of water from the reservoir is maintained for use by them. A hydro-electric plant was built to utilize the water which goes downstream to the mills.

The purification works consist of an influent aerator, a head house for storage and application of coagulant, a rotary mixer, two coagulating basins of 31 million gallons and 94 million gallons capacity, respectively; ten rapid sand filters with a rated

Table of Modern Street Lighting Practice

Class of Street	*Mounting Height*	*Spacing*	*Lumens per Standard*	*Average Horizontal Illumination, F. C.*	*Uniformity Factor*
Main business	18 to 25	100 to 140 (Opp.)	20,000 to 75,000	1.3 to 3.0	.75
Minor business	15 to 18	100 to 150 (Opp.)	10,000 to 30,000	.8 to 1.5	.75
Main traffic arteries	15 to 17	120 to 160 (Opp.)	6,000 to 20,000	.5 to 1.0	.70
Minor traffic arteries	14 to 16	100 to 140 (Stag.)	4,000 to 10,000	.2 to .3	.60
Residence districts	12 to 15	110 to 150 (Stag.)	2,500 to 6,000	.1 to .2	.40
Park drives	12 to 15	125 to 200 (Stag.)	2,500 to 4,000	.1 to .15	.35
Minor residence districts	18 to 25	150 to 200 (Stag.)	2,500 to 4,000	.1 to .12	.25
Warehouse districts	18 to 25	150 to 250 (Stag.)	2,500 to 4,000	.08 to .12	.25
Alleys	18 to 25	180 to 250 (Stag.)	2,500 to 4,000	.08 to .12	.40
Highways	25 to 35	250 to 350 (O. S.)	2,500	.05 to .10	.50

NOTE: The first six classes of streets should be lighted with ornamental equipment; the last four with utilitarian.

Opp. = Opposite Spacing. Stag. = Staggered Spacing. O. S. = One Side of Roadway. Uniformity Factor = $\frac{\text{Minimum F. C.}}{\text{Maximum F. C.}}$

capacity of 48 million gallons per day, an effluent aerator, and a chemical house for the storage and application of lime and chlorine.

When the plant was first put into operation, only six filters had been completed and the smaller of the two coagulating basins. The other four filters had been completed and put into service by January 1, 1927, and the other coagulating basin was put into use on February 1, 1927.

The operation of this plant during its first year of service was described in a paper before the New England Water Works Association by Julius W. Bugbee, city chemist of Providence, and Elwood L. Bean, resident chemist of the Providence filtration plant. The following information concerning the first year's service has been taken from this paper.

During the year the water was withdrawn from the storage reservoir at a point about 40 feet below the water surface and the same distance above the bottom of the reservoir. This appeared to be the most desirable point, as the distance from the surface insured freedom from ice troubles in winter and most of the micro-organisms in summer, while iron and color were lower than if the water had been taken from the extreme depth.

Alum was used as a coagulant throughout the year, the quantity varying between 0.7 and 0.5 grain per gallon, except for a short period in November and December, when one grain was applied. At first alum was added before aeration, but it was found that the distance between the alum feed line and the lines leading to the several aerator nozzles was too short to allow of thorough mixing, and the greater part of the alum solution passed through the first of the aerator nozzles. Therefore, alum was applied after aeration until changes had been made to secure thorough mixing of the alum with the water.

AERATION

Carbon dioxide content of the raw water varied between 2 and 9 p.p.m. Starting at 5 p.p.m. in October, it increased to 6 in November, then slowly decreased to 3.5 in December, again increased during the cold weather to a maximum of 8.5 in late January, then decreased slowing to a minimum of 2 in early May, with another increase to 9 in early August.

The amount of CO_2 which was removed by aeration varied with fluctuations in the raw water content and with the temperature. With the raw water temperature at 50° F. and the air temperature at 60° in February, March, and April, aeration reduced the CO_2 from 8 to 5 p.p.m., from 6 to 4, and from 4 to 3; but when only 2 p.p.m. were present, the reduction was 0.3 p.p.m. In May, June, and July, with water temperatures between 50° and 60° and air temperatures between 60° and 80°, the CO_2 was reduced from 8 p.p.m. to 4, from 6 to 3.2 and from 4 to 2.5.

The changes in pH due to aeration have corresponded closely with the changes in CO_2. Raw water of pH 6.1 has been raised to 6.4; from 6.5 to 6.8; from 6.7 to 6.9, and from 6.9 to 7.0.

Efficiency of aeration was affected somewhat by the head under which the aerators operated, which in turn varied with the level of water in the reservoir. At the maximum height of the reservoir, the height of spray could be made to vary between 7 and 15 feet, depending upon the number of sets of nozzles in use. With this head, by using a single set of nozzles or various combinations of two, three or four sets, it was possible to obtain fifteen different rates of discharge varying between 20 and 85 m.g.d.

COAGULATION

Experiments established 5.8 as the optimum pH for coagulation of this water. Good floc formation and color removal take place when the pH is as low as 5.4, but alum is present in the filtered water when the pH of the treated water is below 5.7. It was found that aerating the water after alum treatment and thereby raising the pH above 6.1 was detrimental to floc formation; and that using alum alone for a coagulent, proper floc formation will not take place above pH 6.2. In operation, the pH of the treated water has been maintained between 5.7 and 6.2.

In March some experiments were made with sodium aluminate. The water used in the experiment had a pH of 6.5, alkalinity 5 p.p.m., and color 37 p.p.m., and required 0.6 grain per gallon of alum for proper floc formation and color removal. Used in conjunction with sodium aluminate, 0.4 grain of alum was required with either 0.1, 0.2, or 0.3 grain of aluminate, and 0.2 grain of alum with 0.5 grain of aluminate. The only apparent advantage of this treatment was a reduction of 1 to 2½ p.p.m. in the CO_2 content of the filtered water.

The alum was applied by means of dry feed machines and it was found that best results were obtained by using only alum from which all dust had been removed by passing over a screen of 10 meshes per lineal inch, and all particles which would not pass through a ¾-inch screen. This also prevented dust nuisance in the building.

Mixing of the alum solution and the aerated raw water is accomplished in a circular tank 35 feet diameter and 30 feet deep. The treated water enters tangentially at the bottom and discharges at the top into the north coagulating basin. Thorough mixing is found to be accomplished.

It was found during the four months in which only the small coagulation basin was used that this did not give sufficient mixing. During this time the length of filter runs varied between 4 and 25 hours, with an average of only 13 hours. After the second basin had been put into service there was no run less than 11 hours, a maximum run of 68 hours, and the average for a 6-month period was 29 hours.

LENGTH OF WASH

In February, with the filter temperature averaging 36°, slightly longer runs resulted from a 16-inch wash for 3 minutes than from washes at other rates. With the temperature at 42 to 50° in April, the longest runs followed washes of 3 minutes at a 19-inch rate, giving a sand expansion of 35 to 40 per cent. In May, average runs of 30 hours or more followed washes with 30 to 35 per cent expansion, while less than a 25-hour average was obtained with over 40 per cent expansion. With a filter temperature of 60° to 65° in June, it was found that while washes of 25 to 27 inches (sand expansion 35 to 40 per cent) resulted in slightly lower initial loss of head than washes of 20 inches, yet the length of runs was not increased,

the loss of head increasing more rapidly during the first few hours of the run.

A tendency to form mud balls while washing at the higher velocities was noted also. In July the average run of filters with 20 per cent expansion was 10 per cent more than those washed at 30 per cent expansion. These results seem to indicate that the percentage sand expansion necessary to secure maximum length of filter runs is not constant, but varies between 20 and 40 per cent.

A length of wash of less than three minutes, calculated between the time of opening and closing the controls, has at all times proved to be insufficient, while washes of more than three minutes have shown little or no advantage. Two minutes from the time of opening the hydraulic controls for the wash gates is required before maximum expansion of the sand is reached. A three-minute wash, calculated as stated, allows two minutes of maximum expansion of the sand, with a total time of flow of 4¼-minutes.

When expansion reaches 40 per cent, some sand is lost, while at 50 per cent expansion, it would waste very rapidly. The original depth of sand placed in the filters was 30 inches and there has been a constant decrease in depth, with an increase in effective size. Between December 1, 1926, and August 1, 1927, the depth decreased from 28.8 inches to 27.3 inches, and the effective size of 0.37 m.m. had increased to 0.40 m.m. The uniformity coefficient remained practically constant at 1.45.

EFFLUENT AERATION

Carbonic acid in the filter effluent varied from 3.5 to 9.9 p.p.m., the maximum being the December average, when the alum treatment was 1 grain per gallon, with one coagulating basin in service. When the second basin was put in commission, the CO_2 dropped to 7 p.p.m., with a constant decrease to 2.5 p.p.m. in August. The corresponding figures for pH were 5.9 in December, increasing to 6.5 in August. Removal of CO_2 by effluent aeration has varied with air and water temperatures and with the CO_2 content of the filtered effluent. In February an effluent containing 6.7 p.p.m. of CO_2 lost 2.1 p.p.m. by aeration; in April 3.7 p.p.m. was reduced by only 0.6 p.p.m., while in July 3 p.p.m. was reduced to 2.

Hydrated line has been used continuously to supplement the work of the effluent aerator in the removal of free carbonic acid. The pH of the aerator effluent has varied between 6.0 in December and 6.7 in July, with corresponding variations of CO_2 between 8.0 and 2.5 p.p.m. By adding amounts of hydrated lime varying from 10 to 40 pounds per million gallons, the pH of the final effluent has been held very uniformly at 7.4, with a CO_2 content of 1.5 p.p.m. Examination of water from lead service pipes has been continued through the year and no sample examined showed lead in excess of 0.05 p.p.m.

OPERATING FORCE

Because of the storage capacity furnished with both coagulating basins in operation, it is possible to concentrate the influent aeration and alum treatment into the 8 hours between 8 A.M. and 4 P.M. and thus reduce the operating force to one man between the hours of 4 P.M. and 8 A.M. The force at present consists of a chemist, a master mechanic, three men on the day shift, one man on the night shift from 4 to 12 and one from 12 to 8. A relief operator, who works four days per week from 8 A.M. to 4 P.M. and two days from 4 P.M. to 12 P.M., provides one day off in seven for all employees, and also permits alternating the two night men on the second and third shifts.

Mr. Buckeley stated that, because of changes made during the year, no reliable cost figures could be given, but the estimate for the coming year was $4.34 per million gallons, based on running the plant at half its capacity. If it were run at full capacity, the additional labor, chemicals and power required would bring the cost from $38,000 to $60,050, which would give a cost of $3.46 per million gallons.

Paving Done in 1927

Statistics received from officials of more than seven hundred municipalities relative to amount of each kind of pavement laid during the year, and cost of same

For the twentieth time we present annual statistics of paving done by cities, tabulated from questionnaires kindly filled out for us by city officials. In 1909 about three hundred cities were represented in the tables; this year a few over seven hundred have been received to date, with others still coming.

Considerable change in paving practice is noticed in comparing the first tabulation and this year's. Comparing percentages of the total number of cities reporting each kind of pavement in 1909, we find brick in 73%, macadam in 65%, asphalt in 38%, stone block in 25%, wood block in 13%, and the other kinds all under 10%.

The figures in the following tables were sent in reply to a request for the amounts of pavement laid during the year 1927, in square yards or miles; also the total cost, stating for each kind of pavement what items are included in the cost (wearing surface, base, grading, curb, etc.). The last-named information, when given by our informants, will be found in the foot-notes at the end of each table.

Information concerning the kind of pavement used on bridges, contractor's guarantees, and solving traffic problems, which also was contained in the questionnaires, will be found summarized elsewhere in this issue.

Sheet Asphalt Paving Done in 1927

City and State	Amount sq. yds. or miles	Cost	Thickness of binder	Thickness of top	Thickness of base	Kind of Base
Alabama:						
Birmingham	60,786	$128,393	....	....	5-6	Concrete
Fairfield	42,000	49,000	1½	....	5	Concrete
California:						
Long Beach	96,570	277,697	....	....	..	Concrete
San Diego	242,612	.....	....	....	..	.....
San Mateo	244	170	....	2	3	.....
Connecticut:						
Hamden	14,000	36,000	1½	1½	6	Stone
Hartford	88,256	261,701	....	3	6	.....
New Haven	102,000	216,000	1½	1½	6	Conc.& Stn.
Norwich	5,360	18,800	3	2	4	Concrete a
Stamford	9,108R	14,836	....	....	..	.....
Florida:						
Miami	348,615	998,671	....	....	..	.....
Sanford	70,320	137,817	None	2	6	Rock
West Palm Beach	91,000	295,750	1½	1½	6	Concrete
Georgia:						
Savannah	25,182b	82,221	....	1½	4	Block
Illinois:						
Chicago	1,085,000	.....	2	1½	6 & 8	.....
Cicero	71,149c	279,590	....	3	7	Concrete
Joliet	22,400	.....	....	....	..	.....
Oak Park	163,780	939,542	2	1½	8	1:2½:5 Conc.
Venice	23,000	109,000	3½	1½	5	Concrete
Indiana:						
Fort Wayne	6.8	466,338	1	1½	6	1:2:3 Conc.
Gary	70,864	263,890	1	1½	..	Macadam
Huntingdon	35,450	110,604	1	1½	6	Concrete
Indianapolis	93,336	305,364	1½	1½	6	1:2½:5 Conc.
Kokomo	13,200	43,000	1½	1½	..	Old stone
La Porte	13,687	56,504	1½	1	7	Concrete
Logansport	7,454	27,918	1½	1½	6	1:3:5 Conc.
Michigan City	5,920	24,606	1	1½	..	.....
Muncie	8,680	11,362	1	1½	..	Macadam
Iowa:						
Burlington	9,450	18,423	1½	1½	..	Old brick
Newton	21,278	56,784	1½	1½	5	.....
Kentucky:						
Paducah	4	252,000	1½	1½	6	Concrete
Maryland:						
Hagerstown	9,857	.....	1	2	6	Concrete
Michigan:						
Detroit	3,179,609	11,466,971	1½	2	8	1:2½:4½ Conc.
Flint	119,365	.....	1½	1½	7-8-9	Concrete
Grand Rapids	317,613	1,185,706	1½	1½	6	Concrete
Hamtramck	46,995	.....	....	....	..	.....
Highland Park	52,032d	26,802	2	1½	8	.....
Holland	66,900	219,275	1¼	1½	4	Block
Kalamazoo	59,719	139,884	1	1½	6	Concrete
Pontiac	38,067	196,000	1½	1½	9-11	Concrete
Port Huron	8,850	15,593	1	1½	..	Old brick
Saginaw	117,040	453,724	....	....	..	.....
Minnesota:						
Rochester	1,000	627	....	1½	..	Old base
Missouri:						
Independence	15,210R	24,360	....	2	..	Mac & Conc.
St. Louis	61,394	313,955	1½	1½	6-8	1:3:6 Conc.
Nebraska:						
Grand Island	4,679	11,043	1	1½	5	Concrete
Lincoln	1,740	.....	....	....	..	.....
Omaha	44,872R	62,010	....	....	..	.....
Scottsbluff	13,740	46,380	1½	1½	5	Concrete
New Jersey:						
Atlantic City	16,395	.....	1½	1½	6	1:3:6 Conc.
Camden	84,243	265,729	1-1½	1-1½	6-8	Concrete
Englewood	31,580	52,400	....	....	..	.....
Jersey City	104,139	640,156	1½	2	6	Concrete
Newark	340,561	1,997,348	1½	1½	6	Concrete
New Brunswick	40,459	180,483	None	2	5	1:3:6 Conc.
Plainfield	81,140	397,944	1½	1½	6-8	Concrete
Trenton	48,120	197,442	1½	1½	6-8	Concrete
New York:						
Geneva	13,000	70,000	1	2	5	.....
New York: Brooklyn	55.97	4,477,000	1	2	6	Concrete
Niagara Falls	37,214	239,786	1	2	6	Concrete
Poughkeepsie	11,878	47,512	1	2	6	Concrete
Rochester	183,781	1,431,947	1	2	6-9	Concrete
Schenectady	36,535	258,159	1	2	6	1:2:4 Conc.
Syracuse	323,555	999,316	1½	1½	7-8	Concrete
Tonawanda	2,875	11,650	1	1½	..	.....
North Carolina:						
Asheville	59,367	319,464	....	....	..	.....
Durham	150,000	700,000	....	....	..	.....
Winston-Salem	267,000	700,000	1½	1½	4-5-6	1:3:6 Conc.
Ohio:						
Ashtabula	13,520	82,188	....	....	..	.....
Barberton	48,827	203,150	1½	1½	6	Concrete
Canton	21,400	70,473	....	....	..	.....
Cleveland	102,320	516,026	1½	1½	8	Concrete
Columbus	253,700	.....	....	1½	6	Concrete
Conneaut	15,441	72,417	1½	1½	4½-6	Blk. or Conc.
Cuyahoga Falls	23,000	120,000	....	....	..	.....
Elyria	770	2,318	1	1½	..	Old brk. or mac.
Fostoria	2,000	.....	1	1½	6	1:2½:5 Conc.
Hamilton	19,500	76,590	1	2	6	Concrete
Lakewood	42,159	185,585	....	....	6-8	.....
Lancaster	12,085	40,909	1	1½	..	.....

City and State	Amount sq. yds. or miles	Cost	Thickness of binder	Thickness of top	Thickness of base	Kind of Base
Massillon	28,000	$112,000	....	....	..	.....
Middletown	35,143R	10,608	1½	1½	8	Concrete
Sandusky	29,535	100,476	....	....	..	.....
Shelby	19,000	60,000	1	1½	5-6	Concrete
Springfield	11,796	44,083	....	....	..	.....
Toledo	164,894	.....	1½	1½	7-8	1:3:5 Conc.
Warren	2,780IR	45,628	....	....	..	.....
Wooster	15,527	62,781	0-1½	1½-2	..	.....
Zanesville	13,775	75,247	1½	1½	6	Concrete
Pennsylvania:						
Butler	20,200	32,600	....	2½	6	Concrete
Franklin	14,500	27,526	....	....	..	.....
Harrisburg	70,000	.....	1½	1½	6-7	1:3:6 Conc.
Scranton	55,315	.....	1	2	6	Concrete
Sharon	1.89 mi.	118,411	1	1½	6	Concrete
Wilkes-Barre	35,400	171,690	1½	2	6	Concrete
York	34,696	120,375	1	2	6	Concrete
Rhode Island:						
Providence	71,204	186,772	1½	1½	..	.....
South Carolina:						
Charleston	81,946	.....	....	....	..	.....
Tennessee:						
Knoxville	41,000	37,720	....	....	6	1:2½:5 Conc.
Virginia:						
Danville	4,000	6,000	....	3	6	Concrete
Richmond	70,665	195,607	....	....	..	.....
West Virginia:						
Charleston	3,302R	12,867	1	2	..	.....
Wisconsin:						
Appleton	4,364	.....	1½	1½	5	1:3:6 Conc.
Fond du Lac	65,158	220,080	1	1½	6	Concrete
Green Bay	40,000	125,000	1	1½	6	Concrete
Kenosha	69,766	152,787	1½	1½	6	1:3:6 Conc.
Milwaukee	38,320f	110,745	....	....	..	.....
Oshkosh	27,132	87,946	1	1½	7	Macadam
Watertown	14,000	17,500	1	1½	..	Old brk base
Canada:						
Brantford	7,320S	4,566	....	....	..	.....
Charlottetown	11,954	32,393	....	2	4	Concrete
Hamilton	160,474	323,682	1½	1½	6	Mac. & conc.
Kitchener	5,850	38,015	1¼	1	..	1.3:6 Conc.
London	50,639	141,789	1½	1½	6	Concrete
Saint John	13,346	45,663	1½	1½	..	Old mac.
Sherbrooke	135,415	365,620	....	....	..	.....

S—surfacing; R—resurfacing; a—also 7-inch crushed stone; b—also 13,007 sq. yds. resurfacing which cost $14,663 additional; c—also 78,648 sq. yds. resurfacing, which cost $157,286; d—includes some repaving; f—also 84,366 sq. yds. resurfacing, which cost $135,829; l—lineal feet.

Rock Asphalt Laid in 1927

City	Area	Cost
Sheffield, Ala.	12,276	$16,362b
Pine Bluff, Ark.	22,000	.....
Middletown, Conn.	19,029	45,448h
Orlando, Fla.	0.5 mi.	.....
Cairo, Ill.	3,000	4,500
Decatur, Ind.	5,232	7,500
Lafayette, Ind.	8,554t	12,008
La Porte, Ind.	9,122	21,008
Richmond, Ind	4,496	9,986b
Greenfield, Mass.	1,744	3,519
Pittsfield, Mass.	1,236	3.70f
South St. Paul, Minn.	1,000	1,200a
Columbia, Mo.	3,162	7,332l
Berlin, N. H.	9,000	1.20f
Hastings, N. Y.	12,500	23,000
Kingston, N. Y.	1,490	.....
Delaware, O.	5,632	5,350i
New Brighton, Pa.	5,000	6,545
New Castle, Pa.	13,967	23,897gcn
Big Spring, Tex.	60,000	180,000ge
Corsicana, Tex.	100,000	300,000g
Dallas, Tex.	44,093	171,008ge
Mexia, Tex.	52,400	136,240gks
Paris, Tex.	20,000	10,000
Rusk, Tex.	20,000	75,000
Rutland, Vt.	5,740	7,915t
Newport News, Va.	4,393	6,050
Charleston, W Va.	3,553	13,599gcn

a—all items included; b—includes base; c—includes curb; e—includes curb and gutter; f—per square yard; g—includes grading; h—includes inlets; i—resurfacing; k—includes manholes; l—includes reconstructing macadam base; n—includes drainage; s—includes gutter; t—surface course only.

Warrenite-Bitulithic Laid in 1927

City	Area	Cost
Birmingham, Ala.	231,328	$603,224
Glendale, Calif.	33,738	42,510d
Richmond, Calif.	51,160	155,762b
Santa Monica, Calif.	32,852	137,249b
Pueblo, Colo.	14,800	2.25f
Bridgeport, Conn.	56,480u	140,800
	40,780v	134,400
West Palm Beach, Fla.	120,000	416,400b
Boise, Ida.	26,336	61,896
Jacksonville, Ill.	10,000	.....
Blurington, Ia.	19,400	42,344a
Centerville, Ia.	20,985	44,000i
Keokuk, Ia.	95,109	176,808cg
Henderson, Ky.	46,464	133,609bghk
New Bedford, Mass.	31,181	.....
St. Cloud, Minn.	35,125	109,023g
St. Louis, Mo.	146,784	865,414gc
Somerville, N. J.	3,900	6,000g
Albuquerque, N. M.	170,000	480,000g
Batavia, N. Y.	20,643	113,111 gchkm
Binghamton, N. Y.	72,311	320,978a
Hempstead, N Y.	0.75 mi.	30,000
North Tonawanda, N. Y.	22,162	1.78fi
Rochester, N. Y.	26,188	86,267gcm
Tonawanda, N. Y.	19,230	79,020gc
Utica, N. Y.	121,200	646,200gcn
Fargo, N. D.	16,878	72,607a
Minot, N. D.	120,600	394,832
Allentown, Pa.	11,993	43,125ge
Harrisburg, Pa.	23,000	.....
Johnstown, Pa.	48,468	242,097gc
Abilene, Tex.	183,767	595,094ge
Brownsville, Tex.	120,000	276,000p
Cleburne, Tex.	250,000	.....
Dallas, Tex.	108,555	366,837ge
Richmond, Va.	4,956	15,274ge
Appleton, Wis.	17,398	.....

a—all items included; b—includes base; c—includes curb; d—pavement only; e—includes curb and gutter; f—per square yard; g—includes grading; h—includes inlets; i—resurfacing; k—includes manholes; m—includes storm sewers; n—includes drainage; p—2½-in. black base on 3-in. rolled gravel; u—on old macadam; v—on new macadam.

Vibrolithic Laid in 1927

City	Area	Cost
Monterey, Calif.	36,111	.....
Oxnard, Calif.	15,800	.....
Pasadena, Calif.	18,404	$55,125a
San Mateo, Calif.	8,340	.....
Des Moines, Ia.	15,727	32,389a
Fort Dodge, Ia.	10,500	26,019gc
Beatrice, Neb.	12,241	36,044gc
Hastings, Neb.	8,950	27,886ge
Fargo, N. D.	23,494	87,995a
Pawhuska, Okla.	2,225	9,811
Tulsa, Okla.	32,088	149,818gcm
Altoona, Pa.	12,925	55,731
Aberdeen, S. D.	24,790	68,316gc
Big Spring, Tex.	1 mi.	160,000ge
Milwaukee, Wis.	489,851	1,156,600d
Two Rivers, Wis.	46,000	100,000gc

a—all items included; c—includes curb; d—pavement only; e—includes curb and gutter; g—includes grading; m—includes storm sewers.

Asphaltic Concrete and Asphaltic Macadam Laid in 1927

City and State	Asphaltic Concrete Area	Concrete Cost	Asphaltic Macadam Area	Macadam Cost
Alabama:				
Birmingham	275,166	$657,009	.....	.....
Arkansas:				
Fayetteville	4,000	10,000	.....	.....
California:				
Berkeley	.....	.....	7,180	$9,990
Fresno	60,229	35,897	.....	.....
Glendale	43,447	75,113	.....	.....
Long Beach	1.5	66,327	.....	.....
Monterey	33,333	1.98a	.....	.....
Napa	.....	.....	15,000	14,250
Ontario	100,000	180,000	22,222	20,000
Palo Alto	2,500	5,800	.....	.....
Pasadena	24,372	57,503	113,974	104,821
Richmond	52,418	109,156	2,890	3,688
San Diego	54,070	.....	.....	.....
San Mateo	90,000	90,000	.....	.....
Santa Monica	109,634	224,383	.....	.....
Santa Paula	73,333	110,500	.....	.....
Ukiah	7,777	20,000	.....	.....
Colorado				
Greeley	49,278	73,966	.....	.....
Connecticut				
Bridgeport	50,000b	50,000	.....	.....
Hamden	3,455	6,323	.....	.....
New Haven	.....	.....	69,000	101,000
Norwich	.....	.....	5,988t	31,600
Stamford	.....	.....	16,159ct	.....
Wallingford	.....	.....	17,000	.....
Florida:				
Orlando	.....	.....	2.5 mi. t	.....
St. Augustine	.....	.....	64,566	1.90s
Sanford	.....	.....	43,800	61.320
West Palm Beach	.....	.....	162,000	83,000
Idaho:				
Pocatello	3,120	6,150	.....	.....
Illinois:				
Chicago	236,000t	.....	.....	.....
Indiana:				
Anderson	52,807d	188,969	.....	.....
Fort Wayne	9.1e	654,346	.....	.....
Gary	.....	.....	12,638	49,240
Hammond	10,000	25,000	35,000	60,000
Indianapolis	59,658	219,857	.....	.....
Muncie	45,229	87,615	3,922t	7,843
Richmond	.....	.....	27,540t	39,279
Iowa:				
Charles City	.....	.....	528	.....
Clinton	.....	.....	2,660t	5,052
Davenport	13,987	46,589	.....	.....
Kansas:				
Leavenworth	46,506	94,805	7,000	2,800
McPherson	17,229	21,131	.....	.....
Newton	20,762	29,813	.....	.....
Topeka	128,145	555,870	.....	.....
Wichita	74,600	270,920	.....	.....
Kentucky:				
Fort Thomas	.....	.....	992	4,858
Maine:				
Portland	.....	.....	5,992	11,907
So. Portland	.....	.....	2,400	5,000
Westbrook	3,600	7,104	.....	.....
Maryland:				
Hagerstown	.....	.....	80,000t	1.00s
Massachusetts:				
Barnstable	.....	82,000	.....	.....
Brockton	.....	.....	44,718	90,000
Chicopee	.....	.....	32,291	44,908
Easthampton	.....	.....	3,000t	7,800
Ohio:				
Bedford	.....	.....	2,400	6,930
Cleveland	348,819	1,713,392	.....	.....
Columbus	9,410	.....	13,500	.....
East Liverpool	3,170	6,504	.....	.....
Elyria	.....	.....	14,425g	19,326
Fostoria	.....	.....	20,000t	.....
Gallipolis	.....	.....	1,000	.....
Hamilton	7,750	22,221	.....	.....
Kenmore	6,433	32,169	.....	.....
Lakewood	14,083	80,916	.....	.....
Oklahoma:				
Tulsa	156,226	537,824	.....	.....
Oregon:				
Astoria	21,020	37,369	.....	.....
Oregon City	26,160	25,638	.....	.....
Portland	272,373	615,292	.....	.....
Pennsylvania:				
Chambersburg	.....	.....	10,200t	7,400
Elizabethtown	.....	.....	13,200t	6,200
Freeland	.....	.....	36,000	8,000
Harrisburg	6,000	.....	.....	.....
Lansford	12,800	60,000	.....	.....
Northampton	.....	.....	13,660	.....
Perkasie	.....	.....	½mit	1,075
Shenandoah	10,405	55,979	.....	.....
Towanda	.....	.....	13,110t	8,046
Rhode Island:				
Providence	.....	.....	214,914	514,400
Woonsocket	.....	.....	48,712	2.40s
Tennessee:				
Jackson	.....	.....	21,450	23,000
Knoxville	70,850	61,775	.....	.....
Texas:				
Corpus Christi	225,000	675,000	.....	.....
Denton	40,000	160,000	.....	.....
Utah:				
Salt Lake City	.....	.....	32,013	.....
Vermont:				
Burlington	.....	.....	20,400	1.50s
Rutland	.....	.....	7,500	8,894
Virginia:				
Danville	4,000	11,200	.....	.....
Lynchburg	19,000	17,000	.....	.....
Newport News	.....	.....	39,678	28,000
Salem	.....	.....	11,200	12,816
Staunton	.....	.....	18,000	15,000
Washington:				
Walla Walla	69,500	141,400	.....	.....
West Virginia:				
Williamson	26,884	53,638	.....	.....
Wisconsin:				
Baraboo	.....	.....	1,500t	3,000
Kenosha	56,679	109,390	.....	.....
Milwaukee	62,669	181,113	240,092t	220,650
Oshkosh	9,059	32,455	.....	.....
So. Milwaukee	.....	.....	20,000t	35,000
Wausau	900	1,100	.....	.....
Wyoming:				
Laramie	38,000	.....	.....	.....
Canada:				
Brantford, Ont.	2,686	7,354	.....	.....
Joliette, Que.	778t	882	10,888	12,610
Kitchener, Ont.	3,494	5,000	6,000t	23,968
Orillia, Ont.	333	.....	.....	.....
Regina, Sash.	40,000	175,000	.....	.....
Sherbrooke, Que.	.....	.....	25,543	63,857
Valleyfield, Que.	14,600t	11,626	.....	.....

a—per square foot; b—surface only; c—3,538 sq. yds. are penetration macadam and the remainder tar concrete; d—emulsified concrete; e—0.1 mile is tar concrete; f—15,350 is tar macadam; g—resurfacing; s—per square foot; t—tar.

Everett	36,200	.....	17,943f	.....
Gardner	.....	.....	27,000t	35,000
Gloucester	.....	.....	37,000	75,000
Greenfield	.....	.....	7,699	13,037
Haverhill	19,387	27,145	25,212	42,737
Lynn	.....	.....	22,381	25,740
Mansfield	.....	.....	3,200t	.....
Milton	.....	.....	12,000	27,000
New Bedford	.....	.....	129,590	.....
Pittsfield	.....	.....	900t	2.75s
Saugus	.....	.....	12,000t	20,000
Wakefield	.....	.....	6,000t	7,000
Watertown	.....	.....	31,144	.....
Michigan:				
Escanaba	.....	.....	25,750	6,314
Grand Rapids	4,323	6,192	.....	.....
Manistique	.....	.....	10,000t	14,000
Midland	.....	.....	1 mi.	.....
Minnesota:				
Minneapolis	34,964	90,051	6,023	7,469
New Ulm	42,310	106,198	.....	.....
Missouri:				
Carthage	3,000	3,600	.....	.....
Columbia	9,773	22,689	.....	.....
Independence	1,699	4,549	.....	.....
Kansas City	60,358	244,941	153,868	323,173
Richmond Hghts.	31,119t	36,675	.....	.....
St. Joseph	188,233	412,270	.....	.....
St. Louis	56,806	335,133	.....	.....
Trenton	.....	.....	1,500g	1,125
University City	.....	.....	21,616	19,250
Montana:				
Glendive	17,000t	20,000	.....	.....
Nebraska:				
Grand Island	16,841	36,818	.....	.....
Lincoln	109,096	.....	.....	.....
Omaha	318,894	750,999	.....	.....
Scottsbluff	26,680	72,720	.....	.....
Nevada:				
Reno	68,431	127,852	.....	.....
New Hampshire:				
Berlin	4,000	3.00s	.....	.....
Laconia	.....	.....	8,336t	12,194
New Jersey:				
Belleville	5,123	.....	.....	.....
Bogota	.....	.....	2,073t	1,658
Camden	23,713	45,379	.....	.....
Elizabeth	9.1	848,000	.....	.....
Englewood	.....	.....	29,885	35,862
North Plainfield	.....	.....	32,000t	58,000
Plainfield	.....	.....	25,600	82,150
Phillipsburg	.....	.....	11,178t	16,767
Salem	2,169	2,711	.....	.....
Somerville	.....	.....	13,000t	15,000
Trenton	.....	.....	2,896	8,360
Westfield	.....	.....	46,000t	131,000
West New York	5,000	15,000	.....	.....
New York:				
Amsterdam	.....	.....	7,800	.....
Beacon	.....	.....	30,000t	.....
Cortland	5,500	19,000	.....	.....
Hastings	.....	.....	58,500	57,000
Ithaca	3,000g	1.25s	.....	.....
New York:				
Brooklyn	.....	.....	.98	52,000
Richmond	74,289	312,286	51,139	137,218
No. Tonawanda	25,933	3.09-3.50s	20,533	.60s
Port Chester	.....	.....	44,000	69,000
Rye	.....	.....	32,666t	62,000
Rochester	.....	.....	9,902	31,973
Syracuse	9,012	39,368	.....	.....
Tarrytown	.....	.....	7,870t	17,628
Utica	1,571	8,500	.....	.....
Watertown	.....	.....	10,282	2.30s
Yonkers	.....	.....	7,842	17,252
North Carolina:				
Durham	50,000	225,000	.....	.....
Raleigh	31,843	.....	11,000t	.....

Stone Block and Brick Pavements Laid in 1927

City and State	Stone Block Area	Stone Block Cost	Brick Area	Brick Cost
Alabama:				
Birmingham	.....	.....	59,056	$236,518
Connecticut:				
Hartford	111	$375	.....	.....
Florida:				
St. Petersburg	.....	.....	23.2	1,941,095
Illinois:				
Cairo	.....	.....	500	3.56s
Chicago	131,000	.....	.....	.....
Hinsdale	.....	.....	160	.....
Streator	.....	.....	1,400	4,885
Sycamore	.....	.....	27,780	48,314a
Waukegan	.....	.....	9,600	52,088a
Indiana:				
Huntingdon	.....	.....	2,375	9,036bcs
Iowa:				
Burlington	.....	.....	7,870	25,883a
Davenport	.....	.....	31,326	78,808a
Des Moines	.....	.....	67,315	199,947a
Iowa City	.....	.....	9,615	42,233a
Kansas:				
Coffeyville	.....	.....	3,908	11,570bcs
Dodge City	.....	.....	20,000	80,000bcs
Independence	.....	.....	6,700	12,500bgm
Newton	.....	.....	36,808	96,708a
Ossawatomie	.....	.....	24,359	54,900
Ottawa	.....	.....	11,200	30,000bs
Wichita	.....	.....	6,217	34,670a
Kentucky:				
Lexington	.....	.....	2,000	4,100bsg
Maine:				
Portland	33,647	170,766	.....	.....
Rockland	1,200	6,000	.....	.....
Massachusetts:				
Everett	732	.....	.....	.....
Lynn	26,000	156,000bs		
Michigan:				
Flint	.....	.....	4,038	.....
Grand Rapids	.....	.....	1,250	5,711a
Kalamazoo	.....	.....	3,085	10,417
Niles	.....	.....	2,000	10,000a
Pontiac	.....	.....	10,294	61,714a
Minnesota:				
Minneapolis	.....	.....	51,442	228,753bsg
Rochester	.....	.....	3,600	4,872
Mississippi:				
Hattiesburg	.....	.....	870	3,200a
Missouri:				
Kirksville	.....	.....	4,574	11,892
St. Louis	76,945	550,772a	10,662	73,120a
Nebraska:				
Fairbury	.....	.....	16,670	67,734a
Omaha	.....	.....	3,669	14,405bsg
New Jersey:				
Atlantic City	924	.....	3,013	.....
Jersey City	9,344	117,016	.....	.....
Newark	5,511	39,518a		
Trenton	20,534	155,969bsg	5,214	27,638bsg
New York:				
Binghamton	.....	.....	4,855	32,807a
Dunkirk	.....	.....	2,365	3.48a
Jamestown	.....	.....	72,000	3.80a
Lancaster	.....	.....	663	7,300a
Lockport	.....	.....	20,830	4.60a
New York				
Brooklyn	3.08 mi	174,000a	.....	.....
Richmond	28,260	31,327bsg	.....	.....

a—asphalt; b—brick; c—concrete; d—emulsified concrete; e—0.1 mile is tar concrete; f—15,350 is tar macadam; g—resurfacing; s—per square foot; t—tar.

Stone Block and Brick Pavements Laid in 1927

City and State	Stone Block Area	Stone Block Cost	Brick Area	Brick Cost
Niagara Falls	.....	.....	26,032	172,237a
Schenectady	8,500	115,986a	11,900	149,864a
Syracuse	.....	.....	10,129	.....
Utica	780	7,391a	13,000	.....
Yonkers	22,753	161,717bs	.....	.....
Ohio:				
Ashland	.....	.....	6,600	28,578a
Bucyrus	.....	.....	3,365	14,727a
Canton	.....	.....	88,634	284,507bs
Circleville	.....	.....	2,300	.....
Cleveland	4,806	50,162a	391,588	1,612,236a
Columbus	.....	.....	60,461	.....
Conneaut	.....	.....	5,888	34,170a
East Liverpool	.....	.....	573	1,550bs
Gallipolis	.....	.....	1,050	.....
Lancaster	.....	.....	10,146	38,199a
Lima	.....	.....	2,800	.....
Massillon	.....	.....	13,000	61,000
Norwalk	.....	.....	4,000	18,000a
Sandusky	.....	.....	7,678	49,372a
Springfield	.....	.....	1,725	6,468
Struthers	.....	.....	4,500	18,000
Toledo	.....	.....	88,051	.....
Zanesville	.....	.....	1,717	3,948bs
Oklahoma:				
Muskogee	.....	.....	8,381	18,675a
Ponca City	.....	.....	33,414	.....
Pennsylvania:				
Butler	.....	.....	5,500	19,000a
Connellsville	.....	.....	2,152	4,711a
Duquesne	.....	.....	12,029	37,891
Greensburg	.....	.....	1,838	10,844a
Greenville	.....	.....	14,000	68,000a
Hazelton	.....	.....	3,041	19,596bsg
Jeannette	.....	.....	3,000	6,000f
Johnstown	.....	.....	20,979	118,734a
Lansford	.....	.....	1,400	10,261a
Meadville	.....	.....	27,230	135,362a
Midland	.....	.....	2,526	13,138a
Monessen	.....	.....	2,100	4,767
Munhall	.....	.....	6,000	.....
New Castle	.....	.....	38,940	184,893a
Pottstown	.....	.....	176	590
Rankin	.....	.....	7,310	27,144
Scranton	18,209	.....	.....	.....
Sharon	.....	.....	0.88mi	47,536a
Warren	.....	.....	3,425	18,694a
Washington	.....	.....	500	1,000
Wilkinsburg	.....	.....	27mi	146,524brs
Williamsport	.....	.....	15,595	71,920a
Rhode Island:				
Providence	12,669h	34,955	.....	.....
Texas:				
Amarillo	.....	.....	309,267	1,093,578a
Dallas	.....	.....	33,139	131,602a
Eastland	.....	.....	40,700	137,900a
Virginia:				
Richmond	16,545	50,855a	9,527	41,473a
West Virginia:				
Charleston	.....	.....	2,611	16,855a
Fairmont	.....	.....	4,500	20,000a
Wisconsin:				
Appleton	.....	.....	1,453	.....
La Crosse	.....	.....	1,000	3,000s
Milwaukee	1,498	9,435bs	.....	.....
Wausau	.....	.....	7,929	23,421a
Canada:				
Hamilton	.....	.....	1,088	3,787bsg
Moncton	.....	.....	200	722
St John	144	497	.....	.....
Sherbrooke	25,543	135,377	.....	.....

a—all items of cost included; b—includes base; c—includes sand cushion; g—includes grading; h—rebuilt; m—curb and gutter included; r—includes curbs; s—includes surfacing.

Concrete Pavements Laid in 1927

City and State	Reinforced Area	Reinforced Cost	Not Reinforced Area	Not Reinforced Cost
Indiana:				
Anderson	.....	.....	5,265	$12,755gr
Bedford	.....	.....	77,500	1.35s
Bicknell	.....	.....	9,500	2.70sg
Brazil	.....	.....	5,000	19,500a
Elkhart	.....	.....	55,238	169,784a
Fort Wayne	1.4mi	$88,609a	.....	.....
Frankfort	3,236	10,194g	.....	.....
Gary	117,395	609,184gr	12,000	31,889gr
Hammond	114,000	350,000	.....	.....
Indianapolis	225,303	601,430a	.....	.....
Kokomo	30,800	92,400a	.....	.....
Lafayette	28,533	70,438g	1,869	3,619g
La Porte	4,081	34,695a	.....	.....
Logansport	.....	.....	23,784	71,663a
Michigan City	88,405	377,229a	.....	.....
Muncie	37,773	90,155g	i	.....
New Albany	.....	.....	39,000	78,000
Peru	14,840	48,666a	.....	.....
Richmond	14,715	38,898b	555	1,443b
Rushville	1,300	3,500gr	.....	.....
Seymour	40,000	120,000a	.....	.....
Tell City	51,100	.....	.....	.....
Washington	.....	.....	1,850	5,087a
Iowa:				
Anamosa	20,000	2.09s	.....	.....
Burlington	.....	.....	80,031	178,390a
Cedar Rapids	.....	.....	10,000	1.85s
Centerville	9,475	24,150a	.....	.....
Charles City	.....	.....	3,880	8,074g
Clarence	21,000	2.11s	.....	.....
Clinton	123,069	356,933a	.....	.....
Davenport	19,318	46,385a	42,527	70,663a
Des Moines	.....	.....	53,499	121,796a
Iowa City	22,733	70,944a	.....	.....
Keokuk	35,578	87,845gr	.....	.....
Mediapolis	20,000	2.10s	.....	.....
Newton	.....	.....	14,596	34,952
Ottumwa	66,345	160,473gr	.....	.....
Kansas:				
Chanute	.....	.....	1,375	2,860g
Dodge City	.....	.....	4,671	9,340b
El Dorado	5,125	17,322gr	.....	.....
Galena	10,028	18,940	17,266	29,620
Independence	10,100	77,000a	13,000	i
Topeka	.....	.....	19,674A	1.70-2.50s
Wichita	136,900	381,540a	i	i
Kentucky:				
Ashland	15,000	70,000	.....	.....
Fort Thomas	41,200	179,194g	.....	.....
Lexington	30,000	77,000g	.....	.....
Maysville	10,500	38,000	.....	.....
Louisiana:				
Jennings	30,000	75,000a	.....	.....
Lake Charles	120,000	318,700a	.....	.....
Maine:				
Bangor	26,318	64,961gr	.....	.....
Rockland	3,333	9,000	.....	.....
Waterville	7,000	24,500	.....	.....
Maryland:				
Hagerstown	.....	.....	14,000	.....
Massachusetts:				
Adams	1,751	5,064	.....	.....
Brockton	13,432	45,000gr	.....	.....
Chicopee	14,521	53,819	.....	.....
Everett	.....	.....	6,125	.....
Gardner	1,160	4,000	.....	.....
Holyoke	72,626	249,922bg	.....	.....
Lawrence	3,810	12,787	.....	.....

Concrete Pavements Laid in 1927

City and State	Reinforced Area	Reinforced Cost	Not Reinforced Area	Not Reinforced Cost
Alabama:				
Bessemer	.....	.....	147,673	$268,782b
Birmingham	.....	.....	151,867	311,421
Fairfield	.....	.....	8,000	18,000
Florence	.....	.....	2,000	4,000a
Arizona:				
Bisbee	.....	.....	98	245
Arkansas:				
Fayetteville	25,000	$60,000	.....	.....
Hot Springs	.....	.....	47blks	160,000a
Pine Bluff	10,000	.....	.....	.....
Prescott	25,000	74,000	.....	.....
Texarkana	.....	.....	12,000	28,000gd
California:				
Berkeley	93	251a	59,838	128,700a
Long Beach	.....	.....	188,357	476,359
Los Gatos	.....	.....	32,900	63,430
Monterey	.....	.....	36,111	1.89s
Oxnard	.....	.....	15,800	.....
Palo Alto	.....	.....	70,000	140,000
Pasadena	.....	.....	95,190	208,293a
San Diego	.....	.....	503,435	.....
San Mateo	1,800	3,888b	75,057	128,668b
Colorado:				
Boulder	.....	.....	670	2,100b
Greeley	.....	.....	18,605	$33,489b
Longmont	.....	.....	14,750	32,287gr
Connecticut:				
Ansonia	.....	.....	17,300	54,000gr
Danbury	600	2,119	11,362	34,461
Manchester	.....	.....	400	1,300
Norwich	.....	.....	7,560	5,000bg
Stamford	14,070	54,000	.....	.....
Florida:				
Miami	.....	.....	169,674	332,892
Georgia:				
La Grange	.....	.....	13,000	28,000
Savannah	.....	.....	100,329	238,750
Idaho:				
Pocatello	.....	.....	12,200	24,180
Illinois:				
Alton	49,639	184,697a	.....	.....
Arthur	15,890	45,310gr	3,261	7,361gr
Belleville	.....	250,000f	.....	.....
Canton	20,000	60,000	.....	.....
Carbondale	9,738	30,108g	.....	.....
Chicago	.....	.....	2,636,000	.....
Cicero	19,298	65,049	13,295	48,018g
DeKalb	44,872	130,989a	.....	.....
East St. Louis	23,853	81,663	.....	.....
Freeport	.....	125,000	.....	.....
Glencoe	908	3,646r	.....	.....
Granite City	30,000	120,000a	.....	.....
Harvey	2mi s	.....	2¼ mi	190,000
Highland Park	97,335	314,879	.....	.....
Kankakee	4,140	10,573	.....	.....
Metropolis	20,000	106,000	.....	.....
North Chicago	16,757	54,693	.....	.....
Oak Park	1,404	7,119a	18,260	66,727a
Pana	9,636	2.43s	.....	.....
Staunton	32,600	112,000a	.....	.....
Sycamore	4,880	15,612a	.....	.....
Vandalia	.....	.....	26,086	92,528a
Venice	1,500	4,500	.....	.....
Waukegan	150,760	53,800a	.....	.....
Wilmette	.....	.....	30,000	2.60sb
Winnetka	7,335	23,475r	.....	.....
New Bedford	.....	.....	678	.....
Pittsfield	18,726	2.64sg	.....	.....
Watertown	14,194	.....	.....	.....
Michigan:				
Ann Arbor	10,000	.....	.....	.....
Bay City	.....	.....	6,532	20,080
Benton Harbor	.....	.....	12,404	39,871a
Detroit	.....	.....	166,032	487,174gr
Escanaba	.....	.....	7,336	26,754
Flint	1,690	.....	.....	.....
Grand Rapids	12,584	61,385a	10,665	27,548a
Hamtramck	.....	.....	15,023	.....
Highland Park	.....	.....	3,192	9,173a
Ironwood	.....	.....	2,200	7,000bg
Kalamazoo	2,850	5,274	.....	.....
Mt. Pleasant	.....	.....	6,000	10,728bg
Port Huron	346	1,183	.....	.....
Pontiac	1,074	.....	.....	.....
Sault Ste. Marie	.....	.....	2,300	11,478
Ypsilanti	.....	.....	17,000	31,000b
Minnesota:				
Crosby	24,092	42,979	.....	.....
Duluth	177,553	409,543	.....	.....
Fairmont	5,402	16,837a	.....	.....
Hibbing	40,470	141,917	.....	.....
Minneapolis	51,923	164,056g	.....	.....
Moorhead	29,335	102,670	.....	.....
New Ulm	3,026	7,292	.....	.....
Red Wing	7,414	16,104	.....	.....
Rochester	1,800	6,163g	.....	.....
South St. Paul	8,500	16,960a	.....	.....
Virginia	.....	45,577	.....	.....
Winona	20,000	2,145	.....	.....
Mississippi:				
Hattiesburg	37,000	78,700b	.....	.....
Missouri:				
Columbia	10,773	33,752a	.....	.....
Independence	3,038	8,100	367	1,000
Kansas City	.....	.....	200,847	679,388g
Kirkesville	6,312	16,042	.....	.....
Mexico	13,000	.....	.....	.....
Richmond Heights	.....	.....	76,850	299,314a
St. Joseph	.....	.....	66,367	194,657g
St. Louis	90,676	379,008a	153,524	385,481a
Sedalia	.....	.....	20,740	35,050
Trenton	3,100	6,600b	.....	.....
University City	25,664	61,603b	.....	.....
Webb City	.....	.....	800	2.00s
Montana:				
Billings	.....	.....	600	2,800
Nebraska:				
Beatrice	14,939	28,308a	.....	.....
Fremont	29,769	58,644	.....	.....
Hastings	28,505	76,299a	.....	.....
Lincoln	.....	.....	5,480A	.....
North Platte	.....	.....	41,613	114,965gd
Omaha	.....	.....	19,781A	32,535a
Nevada:				
Reno	.....	.....	9,546	14,713g
New Jersey:				
Belleville	40,479	.....	.....	.....
Bogota	19,389	74,724a	.....	.....
Camden	.....	.....	4,137	14,157g
Carteret	9,920	27,946	.....	.....
Irvington	61,500	336,500	.....	.....
Millville	3,776	12,230a	.....	.....
Newark	3,446	10,555a	.....	.....
Phillipsburg	5,000	12,500g	.....	.....
Rahway	41,608	151,164r	.....	.....
South Orange	12,000	36,000	.....	.....
Trenton	3,297	9,600g	.....	.....
Westfield	18,115	63,000	.....	.....

Concrete Pavements Laid in 1927

City and State	Reinforced Area	Reinforced Cost	Not Reinforced Area	Not Reinforced Cost
New Mexico:				
Roswell	.....	.....	25,000	$92,000
New York:				
Amsterdam	37,182	$123,710gr	.....	.....
Auburn	30,127	119,862a	.....	.....
Batavia	23,109	98,938	.....	.....
Depew	14,120	82,878a	.....	.....
Fulton	550	1,375b	.....	.....
Glens Falls	12,708	43,122	.....	.....
Gloversville	9,633	56,118	.....	.....
Hudson	.....	.....	28,875	77,479g
Lackawanna	28,000	78,400b	.....	.....
Lancaster	13,755	76,779gdr	.....	.....
Little Falls	4,470	22,353gd	.....	.....
New York:				
Brooklyn	0.83 mi.	86,000a	.....	.....
Richmond	19,211	92,194g	.....	.....
Niagara Falls	.....	.....	15,360	66,082a
North Tonawanda	11,734	43,945	.....	.....
Norwich	6,288	22,787	.....	.....
Oswego	19,044	.....	.....	.....
Port Chester	8,000	26,000b	.....	.....
Rye	43,800	3.50sg	.....	.....
Rochester	6,712	35,491a	.....	.....
Schenectady	4,550k	142,894a	.....	.....
Seneca Falls	4,800	18,000a	.....	.....
Syracuse	80,963	396,334a	.....	.....
Tarrytown	1,968	7,303	.....	.....
Tonawanda	21,800	.....	.....	.....
Utica	18,900	69,400a	.....	.....
North Carolina:				
Asheville	35,806	411,756	65,548	321,757
Winston-Salem	.....	.....	37,900	10,000grm
North Dakota:				
Fargo	78,994	248,050a	.....	.....
Grand Forks	5,570	17,300d	.....	.....
Ohio:				
Bellaire	2,700	24,642a	.....	.....
Bellefontaine	1,225	.....	.....	.....
Bucyrus	8,769	29,144a	.....	.....
Cambridge	20,000	77,000	.....	.....
Campbell	21,000	65,000	.....	.....
Cleveland	21,329	100,902cgh	.....	.....
Columbus	.....	.....	15,000	.....
Cuyahoga Falls	11,000	55,000	.....	.....
East Liverpool	.....	.....	2,080	5,248
Elyria	840	4,319gcy	.....	.....
Fostoria	15,000	.....	.....	.....
Lakewood	1,364	7,005cg	.....	.....
Lancaster	.....	.....	996	2,102cgh
Marietta	6,000	17,359gdh	.....	.....
Newark	.....	.....	6,482	18,846a
Norwalk	2,317	7,939cg	.....	.....
Sandusky	28,663	74,307a	.....	.....
Springfield	77,942	275,880	.....	.....
Struthers	62,000	160,000	.....	.....
Toledo	70,399	.....	.....	.....
Warren	8,6501	108,273	.....	.....
Zanesville	15,443	59,061g	1,978	5,798g
Oklahoma:				
Enid	79,000	227,000gcd	.....	.....
Muskogee	.....	.....	13,500	50,395gcd
Pawhuska	.....	.....	999	3,240
Ponca City	.....	.....	19,654	2.55as
Tulsa	.....	.....	80,255	256,430gcd
Oregon:				
Astoria	.....	.....	14,700	53,310gcdn
Medford	.....	.....	6,000	22,800
Oregon City	.....	.....	4,304	1.60sb
Portland	533,234	1,008,642		
Grafton	.....	$10,000f	.....	.....
Williamson	15,956	96,709gcdw	.....	.....
Wisconsin:				
Antigo	.....	.....	3,000	$6,000
Appleton	10,314	.....	.....	.....
Beloit	18,401	34,750b	.....	.....
Janesville	35,550	85,987	.....	.....
Kaukauna	5,227	13,562gc	12,457	31,946gc
La Crosse	18,160	60,500gc	.....	.....
Madison	79,964	397,750gcd	.....	.....
Milwaukee	5,003	11,589gr		
	10,425	27,381x	163,943	335,402b
Oshkosh	1,737	6,902	.....	.....
	265	661x	.....	.....
Portage	.....	.....	20,410	60,805
Racine	106,000	296,000g	.....	.....
Sheboygan	117,098	256,916g	13,545A	28,705g
Watertown	2,000	2.26sb	.....	.....
Waukasha	.....	.....	52,190	113,788a
Wausau	.....	.....	26,738	61,669g
Canada:				
Cap de la Madeleine, Quebec	.....	.....	12,000	13,800
Guelph, Ontario	.....	.....	16,770	32,339
Kitchener	3,099	14,531g	.....	.....
London, Ontario	.....	.....	340	825
St. Jean, Quebec	.....	.....	16,775	35,964
Sherbrooke, Quebec	.....	.....	14,763	38,383

A—alleys; a—all items included; b—wearing surface only; c—includes curbs; d—includes drainage; f—approximately; g—includes grading; h—includes storm water inlets; i—included in reinforced; k—cubic yards; l—lineal feet; m—includes inspection; n—includes some decorative retaining walls and parkings; p—private; r—includes curb and gutter; S—state aid; s—per square yard; t— repaving 8-in. thick; u—includes bridges; v—includes engineering; w—includes manholes; x—car track zone, pavement only; y—includes sewer connections.

Waterbound Macadam and Gravel Laid in 1927

City and State	Waterbound Macadam Area	Waterbound Macadam Cost	Gravel Area	Gravel Cost
California:				
Glendale	32,034	$37,613b	.....	.....
Colorado:				
Boulder	.....	.....	44,000	$3,800c
Colorado Springs	.....	.....	30,000	6,000
Greeley	35,000	.....	.....	.....
Longmont	.....	.....	20,000	.....
Pueblo	.....	.....	9,000	1.50s
Connecticut:				
Hartford	65,000	110,500g	.....	.....
Manchester	15,000	1.10s	30,000	0.85s
Norwich	1,000	2,500g	.....	.....
Putnam	.....	.....	3,000	2,000
Willimantic	.....	.....	23,350	.....
Idaho:				
Burley	.....	.....	6,500	700c
Illinois:				
Cairo	.....	.....	5,000	5,000
Joliet	600	.....	.....	.....
Indiana.				
Frankfort	.....	.....	816	604
Gary	3,782	15,204gde	.....	.....
Muncie	3,129	5,414g	7,186	6,630g
Richmond	.....	.....	356	570b
Seymour	.....	.....	20,000	17,000a
Iowa:				
Boone	.....	.....	5,300	7,216
Des Moines	.....	.....	3,573	21,502a
Fort Dodge	.....	.....	3,360	730
Van Horne	.....	.....	10,000	5,000

Pennsylvania:				
Allentown	7,121	26,220gr	.....	.....
Altoona	84,005	328,744gc	.....	.....
Bethlehem	24,368	98,865gcdh	.....	.....
Chambersburg	33,762	115,000gh	.....	.....
Clairton	14,390	83,000	.....	.....
Clearfield	7,200	26,000a	.....	.....
College Hill	8,980	27,201gch	.....	.....
Connellsville	18,355	68,465gc	.....	.....
Donora	1,790	8,265	.....	.....
Easton	27,230	100,327g	.....	.....
Frackville	5,613	26,682gc	177	720gc
Franklin	4,189	14,589gcd	.....	.....
Greensburg	15,412 / 5,362t	64,208 / 22,088	..... /	..... / .....
Harrisburg	1,000	.....	11,000	.....
Jersey Shore	7,823	19,626g	.....	.....
Johnstown	20,363	73,305gc	.....	.....
Lehighton	1.5 mi.	97,000a	.....	.....
Lewistown	800	2,700	.....	.....
Monessen	2,100	4,200	.....	.....
Mt. Carmel	.....	.....	1,000	3,900gc
Munhall	15,972	.....	.....	.....
New Brighton	15,000	41,477	.....	.....
New Castle	25,174	.....	.....	.....
Pottstown	6,851	20,349	4,699	10,487
Sharon	0.27 mi.	10,543gr	.....	.....
Tyrone	32,000	106,000gch	.....	.....
Uniontown	.....	.....	3,610	12,539gc
Walnutport	0.5 mi.	38,000a	.....	.....
Washington	33,417	137,282	.....	.....
West View	11,928	90,000gcd	.....	.....
Wilkinsburg	0.6 mi.	22,070gc	.....	.....
Williamsport	12,700	56,482gd	.....	.....
York	25,915	75,860	.....	.....
South Carolina:				
Greenwood	.....	.....	2,500	11,500gd
South Dakota:				
Rapid City	11,071	28,888gc	.....	.....
Watertown	.....	.....	2,500	5,260b
Tennessee:				
Dyersburg	.....	.....	5,000	.....
Jackson	.....	.....	23,624	66,500gc
Knoxville	.....	.....	44,000	80,860
Texas:				
Abilene	4,950	16,099gr	2,364	6,421gr
Corsicana	10,800	.....	.....	.....
Dallas	188	646gr	.....	.....
Houston	33 mi.	1,200,000gu	.....	.....
Mexia	540	1,746g	.....	.....
Utah:				
Provo	.....	.....	15,900	31,700g
Salt Lake City	.....	.....	90,243	348,346grm
Vermont:				
Montpelier	13,530	54,000gy	.....	.....
St. Albans	0.12 mi.	4,640	.....	.....
Virginia:				
Lynchburg	.....	.....	215	464b
Richmond	.....	.....	9,196	22,255grm
Suffolk	.....	.....	1,952	4,392
Washington:				
Hoquiam	.....	.....	28,200	62,000g
Spokane	.....	.....	28,514	59,163gd
Yakima	.....	.....	4,932	11,370
West Virginia:				
Charleston	39,209	220,510gcdv	.....	.....
Clarksburg	13,720	46,086b	.....	.....
Fairmont	.....	.....	14,000	42,000g

Kansas:				
Coffeyville	.....	.....	4,200	1,737
Independence	4,000	4,217ge	.....	.....
Iola	.....	.....	3,562	2,850g
Kentucky:				
Lexington	40,000	.....	.....	.....
Paducah	.....	.....	3.5 mi.	70,000
Maine:				
Auburn	.....	.....	23,600	.....
Bangor	.....	.....	5,000	3,600
Rockland	.....	.....	0.5 mi.	1,637
South Portland	.....	.....	2,400	1,200
Massachusetts:				
Barnstable	.....	.....	.....	14,000
Gloucester	.....	.....	17,000	.....
Mansfield	.....	.....	2,000	.....
Milton	.....	.....	1,500	3,000g
New Bedford	.....	.....	33,339	.....
Newburyport	1 mi.	.....	6 mi.	.....
Newton	.....	.....	4 mi.	76,384
Wakefield	.....	.....	4 mi.f	11,000
Michigan:				
Flint	.....	.....	9.5 mi.	.....
Ironwood	.....	.....	10,500	5,000g
Niles	.....	.....	8,000	.....
Minnesota:				
Duluth	.....	.....	22,909	20,800
Rochester	.....	.....	8,200	6,400
Missouri:				
Columbia	.....	.....	2,185	2,406g
Glendale	14,915	27,137g	.....	.....
St. Joseph	.....	.....	6,000	3,000g
Montana:				
Lewistown	.....	.....	34,156h	83,355gi
Nebraska:				
Beatrice	.....	.....	15,455	5,214
New Hampshire:				
Berlin	15,000	1.50s	8,000	1.25s
New Jersey:				
Englewood	28,000	33,600	.....	.....
Millville	.....	.....	2 mi.f	.....
Salem	.....	.....	5,151	1,288
Vineland	.....	.....	6,000	.....
New York:				
Amsterdam	8,360	.....	.....	.....
Beacon	.....	.....	3,000	.....
Watertown	2,000	2,802	.....	.....
North Dakota:				
Jamestown	.....	.....	0.6 mi.	400
Ohio:				
Cleveland	1,900	5,229gkl	.....	.....
Hamilton	.....	.....	7,858	8,891
Marietta	.....	.....	6 mi.	15,000gl
Sandusky	2,260	3,800a	.....	.....
Springfield	.....	.....	19,685	12,770
Oklahoma:				
Vinita	.....	.....	10 mi.	13,000

Cement Sidewalks Laid in 1927

City and State	Amount sq. yds. or miles	Cost
Alabama:		
Bessemer	11,467	$18,440
Birmingham	90,930	140,710
Fairfield	2,500	3,200
Gadsden	6,619	7,943
Sheffield	6,333f	950
Arkansas:		
Fayetteville	20,000f	5,000
Hot Springs	25,000f	.15f
Pine Bluff	12,000f	.....
California:		
Berkeley	19,577	34,550
Glendale	184,188f	31,103
Long Beach	8.27	191,527
Oxnard	4,000	.....
Palo Alto	2	.....
Pasadena	301,423f	55,872
Richmond	68,910f	13,439
San Diego	800,828f	150,163
Santa Monica	176,700f	31,839
Santa Paula	78,000f	12,800
Colorado:		
Colorado Springs	23,400f	3,610
Golden	400	100
Greeley	55,000f	9,000
Pueblo	5,500f	.....
Connecticut:		
Bristol	92,500f	22,177
Danbury	5,000	.....
Derby	357	.....
Hartford	380,000f	.....
Manchester	2½a	40,000
Norwich	100	360
Putnam	1,000	2,500
Stamford	137,953f	60,000
Willimantic	9,500f	21,800
Florida:		
Miami	20,491	39,248
Orlando	25 mi.	.....
Sanford	10,830	19,440
Idaho:		
Nampa	26,400f	3,960
Illinois:		
Cairo	2,000l	$2,500
Clinton	2,904f	726
Harvey	60,000f	18,000
Hinsdale	26,305l	32,668
Kankakee	4,500f	2,800
North Chicago	6,392	12,392
Streator	10,826f	2,165
Waukegan	11.5 mi.	77,000

City and State	Amount sq. yds. or miles	Cost
Indiana:		
Anderson	107,637f	$31,645
Elkhart	11,700	26,127
Fort Wayne	13.7 mi.	84,663
Frankfort	25,077f	5,783
Gary	74,875	.....
Indianapolis	528,396f	154,309
Kokomo	105,600f	25,400
Lafayette	52,790f	10,718
La Porte	15,000	.....
Michigan City	2,965	533
Muncie	20,259l	20,291
New Albany	6,000	10,800
Seymour	6,000	3,600
Tell City	3 mi.	.....
Washington	6,000f	900
Iowa:		
Ames	50,000f	7,500
Davenport	90,000f	18,000
Fort Dodge	6,000f	900
Kansas:		
Coffeyville	3,333	4,322
Dodge City	20,000f	2,800
Wichita	....	35,000
Kentucky:		
Ashland	2 mi.	20f
Henderson	53,881f	11,111
Lexington	2,000	.....
Paducah	98,000l	186,000
Louisiana:		
Lake Charles	2 mi.	.80l
Maine:		
Auburn	3,269	7,500
Augusta	1,322	3,305
Bangor	1,916	4,923
Rockland	800f	$1,000
South Portland	600	1,580
Massachusetts:		
Barnstable	....	8,000
Brockton	1,893	4,500
Gardner	3,962	10,000
Greenfield	2,400	5,265
Haverhill	2,372	5,065
Lawrence	3,095	2.00s
Lynn	10,211	30,633
Mansfield	300	.....
Milton	2,639	.33f
New Bedford	42,710	.....
Newburyport	2,000f	2.20s
Newton	121,825f	13,234
Pittsfield	900	2.47s
Southbridge	2,000	6,600
Wakefield	4,000	14,000
Watertown	75,522f	.....

Waerbound Macadam and Gravel Laid in 1927

City and State	Waterbound Macadam Area	Waterbound Macadam Cost	Gravel Area	Gravel Cost
Oregon:				
Astoria	5,517	$12,374	.....	.....
Medford	.....	.....	2,000	$4,000
Pennsylvania:				
Lewistown	4,900	2,515g	.....	.....
Rhode Island:				
Cranston	.....	.....	12 mi.	40,000
South Dakota:				
Watertown	.....	.....	2 mi.	.....
Tennessee:				
Clarksville	15,000	6,672	.....	.....
Dyersburg	.....	.....	2,500	.....
Texas:				
Bonham	.....	.....	500	500
Brownwood	.....	.....	22,980	7,583
Houston	.....	.....	15 mi.	85,000gm
Weatherford	.....	.....	35 mi.	.....
Vermont:				
Bennington	.....	.....	2 mi.	2.50s
Burlington	.....	.....	1,700	1.00s
Virginia:				
Lynchburg	40,000	23,000a	.....	.....
Washington:				
Hoquaiam	.....	.....	0 5 mi.	1,200
Puyallup	.....	.....	5,000	2,500gn
Vancouver	.....	.....	10,000	1,500
Wenatchee	.....	.....	8,000	4,000
Yakima	.....	.....	6,458	2,765
Wisconsin:				
Janesville	.....	.....	3 mi.	.....
Watertown	.....	.....	20,000	.....
Wyoming:				
Cheyenne	.....	.....	8,400	.....
Canada:				
Barrie, Ontario	.....	.....	5 mi.	2,508
Charlottestown, P. E. I.	.....	.....	30,000	7,750g
Kitchener, Ont.	.....	.....	7,000	6,893g
Lethbridge, Alta.	.....	.....	1.5 mi	.....
Moncton, N. B.	.....	.....	19,000	.....
North Bay, Ont.	2 mi.	1,600	1.5 mi.	1,200g
Pembroke, Ont.	900	2,000	.....	.....
Port Arthur, Ont.	8,100	14,000	10,000n	.....
St. Boniface, Man.	.....	.....	13,000	.....
Valleyfield, Que.	2,700	4,222	.....	.....

a—all items included; b—pavement only; c—surfacing only; d—includes base; e—includes curb and gutter; f—approximately; g—includes grading; h—cubic yards; l—includes storm sewer; k—includes curb; l—includes catch basins; m—includes bridges; n—includes drainage; s—per square yard.

Miscellaneous Pavements Laid in 1927

City:	Kind of Pavement	Area	Cost
Florence, Ala.	Chert	5,000	$10,000gc
Glendale, Calif.	Oil and rock resurfacing	1,571	1,837
Long Beach, Calif.	Decomposed granite	14,968	15,449
San Diego, Calif.	Concrete, asphalt top	26,957	....
Ukiah, Calif.	Resurfacing oil macadam with Topeka top	7,778	20,600e
St. Petersburg, Fla.	Asphalt block	22.08 mi	2,266,865c
Sanford, Fla.	1½ in sheet asph. on 3 in. sand asph. base	66,000	102,300

Cement Sidewalks Laid in 1927

City and State	Amount sq. yds. or miles	Cost
Michigan:		
Benton Harbor	16,750f	$3,412
Halfway	105,000f	18,000
Holland	39,000f	4,680
Ironwood	53,000f	15,000
Mt. Pleasant	1,500f	752
Pontiac	212,617f	40,000
Port Huron	20,315f	3,462
Saginaw	8.03 mi.	.....
Sault Ste. Marie	2,430f	486
Minnesota:		
Hibbing	227,300f	63,341
Minneapolis	75,000	84,480
Moorhead	600	1,080
New Ulm	1,290f	.....
Rochester	9,000f	1,242
St. Cloud	10,000	9,000
Virginia	....	2,028
Winona	7 mi.	.....
Missouri:		
Columbia	8,000f	2,000
Independence	1,950	3,728
Kansas City	218,785f	38,810
Mexico	2 mi.	.....
St. Charles	1,000	1,000
St. Joseph	40,846f	$11,698
Trenton	30,000f	6,000
Webb City	10,800f	15f
Montana:		
Bozeman	2,700	675
Lewistown	6,000	1,320
Nebraska:		
Omaha	268,346f	31,755
Scottsbluff	10,000	18,000
Nevada:		
Reno	12,140	17,483
New Hampshire:		
Berlin	12,000	1.10s
New Jersey:		
Belleville	44,644f	.....
Carteret	25,502f	7,700
Englewood	11,3901	12,530
Irvington	60,000f	15,000
Plainfield	21,740f	4,730
Somerville	20,000f	.30-.35f
Trenton	11,420f	3,412
Vineland	12,000f	2,400
Westfield	2 mi.	10,500
New York:		
Amsterdam	88,185f	.24f
Binghamton	66,265f	13,250
Corning	4,461	$8,030
Depew	40,000f	.22½f
Gloversville	441	4,310
Hudson	1,800	4,000
Jamestown	4 mi.	.25f
Lancaster	23,000f	.25f
Little Falls	5,000f	1,500
New York-Brooklyn	1,928,688f	270,000
Niagara Falls	126,958f	27,930
Norwich	1,550f	511
Port Chester	3 mi.	24,000
Poughkeepsie	7,512f	1,878
Rochester	891,694f	.....
Schenectady	34,635f	10,953
Syracuse	15.5 mi	82,314
Tarrytown	22,000f	9,900
Utica	14,410	32,400
Watertown	2 mi.	.....
North Carolina:		
Asheville	4,607	9,367
Durham	5,000	9,000
Raleigh	8,852	.....
Winston-Salem	56,000	75,000
North Dakota:		
Bismarck	1 mi.	.....
Fargo	11,103	21,544
Jamestown	2,000	3,870
Minot	29,900f	6,752
Ohio:		
Bellefontaine	1,627f	.....
Cleveland	370,613f	98,250
Elyria	28,300f	5,719
Hamilton	61,904f	12,621
Lima	24,000f	6,000
Newark	....	2,454
Middletown	32,000f	6,400
Painesville	30,160f	5,488
Springfield	140,000f	41,066
Warren	6.8 mi.	45,000
Oklahoma:		
Enid	40,000f	8,000
Muskogee	50,000f	.14f
Ponca City	137,280f	.....
Oregon:		
Astoria	51,429f	15,520
Medford	15,000	21,600
Oregon City	12,065f	1,930
Portland	1,005,059f	.....
Pennsylvania:		
Allentown	6,000	17,000
Berwick	33,600f	.16f
Bethlehem	41,000f	10,250
Chambersburg	19,000f	3,800
Clearfield	500	800
Coatesville	10,000f	3,300
Connellsville	1,000	.....
Donora	11,300f	.....
Greenville	10,000f	.25f
Hanover	20,000f	.16f
Jersey Shore	1,621	2,917
Lehighton	1/8 mi.	.....
Midland	7,912f	1,998
Munhall	36,500f	10,750
Northampton	38,620f	.....
Sayre	....	.22f
Sharon	2.5 mi.	.....
West View	8,150f	2,500
Wilkinsburg	2 mi.	16,000
Williamsport	10,500	.....
South Carolina:		
Union	12,000f	.....
South Dakota:		
Rapid City	12,000f	3,000
Watertown	580	625
Tennessee:		
Knoxville	43,792	59,406
Texas:		
Corpus Christi	500,000f	100,000
Corsicana	24,612f	4,922
Dallas	778,216f	.....
Mexia	1,260f	.....
Utah:		
Provo	3,000	5,500
Vermont:		
Burlington	14,775l	.20f
Rutland	4,160	9,875
St Albans	....	13,000
Virginia:		
Danville	10,000	17,500
Salem	3,225	5,594
Staunton	6,000	12,000
Suffolk	1,949	2,910
Washington:		
Puyallup	2,000	2,050
Spokane	18,344	1.30s
Vancouver	2,222	4,000
Walla Walla	33,000f	.....
Wenatchee	3,000	5,300
Yakima	524	932
West Virginia:		
Clarksburg	4,000	8,300
Wisconsin:		
Antigo	15,000f	.16f
Appleton	933	1,679
Beloit	1½ mi.	475
Green Bay	1 mi.	5,000
Kenosha	117,000f	19,884
La Crosse	20,000f	2,600

Lewiston, Ida.	Crushed rock	0.68 mi.	2,500		
Anderson, Ind.	Emulsified asphalt	52,807	188,970bcg		
New Albany, Ind.	Amiesite	1,300	2,600		
Des Moines, Ia.	Amiesite	9,487	17,496a		
Lexington, Ky.	Amiesite	4,000	11,200bg		
Lynn, Mass.	Vulcanized	9,671	14,505g		
Watertown, Mass.	Gravel and oil	11,013	....		
Grand Rapids, Mich.	Tar Seal	227,265	31,310		
Midland, Mich.	Cinder	0.25 mi.	....		
University City, Md.	Asph. surface treatment of macadam		16,500		
Trenton, N. J.	Cinder		2,393		
Vineland, N. J.	Cinder		....		
Beacon, N. Y.	Asphalt block		120,000gcn		
Lackawanna, N. Y.	Asphalt block		210,560b		
Little Falls, N. Y.	Amiesite		47,163		
Niagara Falls, N. Y.	Asphalt block		142,563a		
Rochester, N. Y.	Willite		209,936gcm		
Cuyahoga, O.	Slag		....		
Altoona, Pa.	Carolite		4,317		
Duquesne, Pa.	Slag with tar filler		10,820		
Hazelton, Pa.	Surface treated gravel		11,247		
Lewistown, Pa.	Tar surfaced		5,600		
Watertown, S. D.	Cinders		....		
Amarillo, Tex.	Gravel, 2-course pene.		288,819a		
Houston, Tex.	Shell		50,000gr		
Burlington, Vt.	Cinders		2,000		
Fredericksburg, Va.	Macadam, asph. coating		7,550		
Richmond, Va.	Granite spalls		30,290ge		
	Amiesite		58,300g		
Keyser, W. Va.	Amiesite		11,000		
Ashland, Wis.	Tavia on old macadam		4,500		
Madison, Wis.	Amiesite		5,850		

Lewiston, Ida.	Crushed rock	0.68 mi.	2,500		
Anderson, Ind.	Emulsified asphalt	52,807	188,970bcg		
New Albany, Ind.	Amiesite	1,300	2,600		
Des Moines, Ia.	Amiesite	9,487	17,496a		
Lexington, Ky.	Amiesite	4,000	11,200bg		
Lynn, Mass.	Vulcanized	9,671	14,505g		
Watertown, Mass.	Gravel and oil	11,013	....		
Grand Rapids, Mich.	Tar Seal	227,265	31,310		
Midland, Mich.	Cinder	0.25 mi.	....		
University City, Md.	Asph. surface treatment of macadam		16,500		
Trenton, N. J.	Cinder		2,393		
Vineland, N. J.	Cinder		....		
Beacon, N. Y.	Asphalt block		120,000gcn		
Lackawanna, N. Y.	Asphalt block		210,560b		
Little Falls, N. Y.	Amiesite		47,163		
Niagara Falls, N. Y.	Asphalt block		142,563a		
Rochester, N. Y.	Willite		209,936gcm		
Cuyahoga, O.	Slag		....		
Altoona, Pa.	Carolite		4,317		
Duquesne, Pa.	Slag with tar filler		10,820		
Hazelton, Pa.	Surface treated gravel		11,247		
Lewistown, Pa.	Tar surfaced		5,600		
Watertown, S. D.	Cinders		....		
Amarillo, Tex.	Gravel, 2-course pene.	1 mi.	288,819a		
Houston, Tex.	Shell	166,020	50,000gr		
Burlington, Vt.	Cinders	10 mi.	2,000		
Fredericksburg, Va.	Macadam, asph. coating	4,000	7,550		
Richmond, Va.	Granite spalls	28,500	30,290ge		
	Amiesite	24,441	58,300g		
Keyser, W. Va.	Amiesite	12,830	11,000		
Ashland, Wis.	Tavia on old macadam	7,000	4,500		
Madison, Wis.	Amiesite	4,500	5,850		

A—All items included. b—Includes base. c—Includes curb and gutter. g—Includes grading. m—Includes storm sewers. r—Includes bridges. e—Includes drainage. n—Includes

Cement Sidewalks Laid in 1927

City and State	Amount sq. yds. or miles	Cost
Madison	13,888	30,000
Milwaukee	1,639,207f	330,124
Racine	10,000	18,000
Wausau	75,556f	11,333
Wyoming:		
Cheyenne	8,000f	.23f
Canada:		
Barrie, Ont.	12,000f	2,000
Joliette, Que.	710	1,080
Kitchener, Ont.	2 mi.	14,332
Moncton, N. B.	2,434f	497
Port Arthur, Ont.	24,000f	.50f
Regina, Sask.	127,350f	.....
St. Boniface, Man.	755	1.78s
St. Thomas, Ont.	3,000f	810
Sherbrooke, Que.	74,807	329,823b
Stratford, Ont.	10,000f	2,500
Valleyfield, Que.	2,030	5,369

A—includes curb and gutter; b—includes curb and gutter, catch-basins, conduits, etc.; f—sq. ft. or per sq. ft.; l—lin. ft. or per lin. foot; s—per sq. yd.

Pavements Used on Bridges and Viaducts

Inquiry as to the kind of pavement used on bridges and viaducts brought replies from about four hundred cities. A considerable number stated that the same kind of pavement was laid as was used on the main thoroughfare leading to the bridge. The pavements named included practically all kinds used on city streets. The list included 100 concrete; 60 wood block; 48 "asphalt" and also 34 asphalt concrete, 23 sheet asphalt ,8 rock asphalt, 7 bituminous macadam, and 8 asphalt block—a total of 128 asphalt; 47 brick; 9 granite block; 33 plank and 5 creosoted plank; 2 Carey floor surfacing.

A few vary material with kind of structure. Birmingham, Ala., formerly used wood block but recently has used Warrenite-Bitulithic. Bridgeport uses asphalt on fixed spans, wood block on movable spans. Minot, N. D., formerly used wood block and brick but will use asphalt. Painesville, O., uses wood block on steel trusses, asphalt-filled brick and concrete on concrete bridges. Pawhuska, Okla., is replacing wood block with asphalt. Connellsville, Pa., has used wood block but finds it too slippery. Miami, Fla., used planks on bascule, asphalt on approaches. Logansport, Ind., uses concrete and brick on concrete bridges, wood block and plank on old iron bridge. New Bedford, Mass., uses plank on draw span, endurite on bridge and viaduct. Bay City, Mich., uses wood on bridges, brick on viaduct. Miles City, Mont., uses planks, may place steel treads on them; which is the practice in Cheyenne, Wyo.

The principal kinds of bridge pavement are reported from all parts of the country; asphalt from 36 states, concrete from 34, brick from 18 and wood block from 18.

New Method of Curing Concrete Pavement

A description of a new process of curing concrete pavements was given in a recent issue of the *Texas Highway Bulletin* by T. H. Brewster, engineer of materials and tests of the Texas Highway Department. This method was tried out on a section of F. A. P. 436-A in Webb County, near Laredo, where severe weather conditions were the rule. The temperature was very high in the daytime, with hot, dry winds, and the nights were cool. Checking occurred during the day, and some cracks appeared due to temperature changes. The new process prevented checking.

Briefly, this, known as the Hunt process, consists of spraying the surface of the finished concrete with a bituminous paint immediately after a final floating and belting, while the concrete is still wet. The method of application is much the same as bridge or automobile painting by means of an air sprayer, and was generally referred to as the "Duco" finish. The application forms a waterproof seal, and after it becomes hard appears to be an integral part of the concrete and cannot be removed.

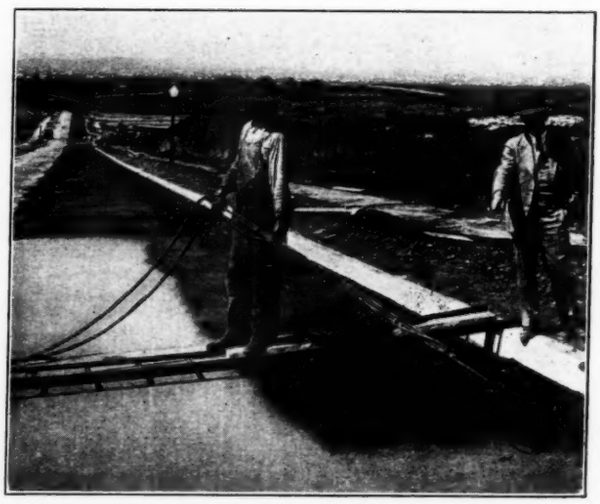
The material used is made from Trinidad or Bermudez and Gilsonite asphalts and contains no oil. It comes to the job as a liquid and is not heated. The equipment needed consists of a small compressor, driven by a gasoline engine, and a long-handled spray nozzle, which enables the operator to reach all sections from the bridge and the sides.

Cores taken from the finished test section, and from a regularly cured section; indicated no difference in strength. Cores taken at 34 and 35 days showed an average strength of 4645 pounds for the Hunt process and of 4640 pounds for the water cured method.

A number of reasons for using this method of curing are given. In the first place it is not necessary to disturb the shoulders in order to get cover material. The contractor does not have to provide canvas or burlap and the problems of providing water and keeping the pavement wet for 14 days are eliminated. The pavement does not have to be cleaned at the end of the curing period, and preliminary tests indicate that traffic can be allowed on the road at an earlier period.

This method has been used on more than six hundred thousand square yards of pavement in Southern California, and also in Oregon, Utah and Texas, and it is said that more than a million square yards are now under contract. It was developed and is being handled by the Everlasting Paint and Sales Co., Los Angeles, Calif.

T. E. Huffman is county engineer on the project on which this test was made and H. B. Zachry the contractor.



SPRAYING BITUMINOUS COAT ON CONCRETE AT LOS ANGELES.

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CONTENTS

PAVEMENT WIDENING IN NILES. Illustrated. By Vernon N. Taggett 85
Trucking Sticky Material 86
Reinforcing Pavement Bases in Clinton. By Benton R. Anderson 86
Below Zero Excavating 87
PAVING PROGRESS IN 1927.
ADVANCES IN THE ART AND SCIENCE OF ASPHALT PAVING IN 1927. Illustrated. By F. P. Smith 87
PROGRESS IN BRICK PAVING PRACTICE IN 1927. By John M. Egan 89
GRANITE BLOCK PAVEMENTS IN 1927. Illustrated. By Clarence D. Pollock 89
RECENT DEVELOPMENTS IN CONCRETE PAVEMENT CONSTRUCTION. By H. Eltinge Breed 90
LOW-COST PAVEMENTS FOR CITY STREETS. Illustrated. By C. N. Conner 92
PAVING PRACTICE IN CLEVELAND 95
A Snow Cleaning Problem 96
New Mexico Paints Highway Equipment Red..... 96
SEPARATE SLUDGE DIGESTION: SLUDGE HEATING AND GAS COLLECTION AT ANTIGO, WIS. Illustrated. By Anthony J. Fischer and Frank K. Quimby..... 97
Refuse Collection in Cincinnati..... 101
LAYING SEWER PIPE IN WATER. Illustrated.. 102
Street Lighting Practice..... 103
PROVIDENCE FILTRATION PLANT..... 103
PAVING DONE IN 1927..... 105
ASPHALT PAVING DONE IN 1927..... 106
ROCK ASPHALT LAID IN 1927..... 107
WARRENITE-BITULITHIC LAID IN 1927..... 107
VIBROLITHIC LAID IN 1927..... 107
ASPHALTIC CONCRETE AND ASPHALTIC MACADAM LAID IN 1927..... 108
STONE BLOCK AND BRICK PAVEMENTS LAID IN 1927..... 109
CONCRETE PAVEMENTS LAID IN 1927..... 110
WATERBOUND MACADAM AND GRAVEL LAID IN 1927..... 112
CEMENT SIDEWALKS LAID IN 1927..... 114
Pavements Used on Bridges and Viaducts..... 116
New Method of Curing Concrete Pavement. Illustrated 116
EDITORIAL NOTES 117
Handling City Traffic—Public Work for the Unemployed—Recognition for Federal Engineers.
Pavement Guarantee 118
A Substitute for Taxes..... 118
Garbage Collection in Summit..... 118
City Sells Plumbing Fixtures..... 118
TRAFFIC TROUBLES IN VARIOUS CITIES.... 119
HIGHWAY PRACTICE IN THE EASTERN STATES 121
RECENT LEGAL DECISIONS 125

Handling City Traffic

Until such time as a considerable part of city traffic travels underground or in the air, it must be handled on the streets. Recent rapid increase in the amount and weight of traffic has created conditions that require for their solution tolerant and ever hearty cooperation between city planners and engineers, police, law makers and the public users of the streets.

The city planners and engineers are held responsible for providing a suitable street layout, and adequate width, strength and surface smoothness of pavements thereon. Strength and smoothness are readily obtainable at reasonable cost; but sufficient number and width is a much more difficult problem.

Involved in the problem of width is that of parking. It might be maintained, and is by some, that streets are provided for moving traffic, both vehicular and pedestrian, and that neither has a right to reduce the traffic area available by standing still for any length of time. On the other hand, taxpayers demand a place for parking, and if they realize what it will cost to provide it and are willing to pay the cost, it is the duty of the city officials to endeavor to comply with their wishes.

The problem of providing for increasing traffic and parking is, in many cities, the most difficult one confronting the city engineering department. For this reason we have paid special attention to it in this issue. What phases of the problem are especially troublesome in several hundred cities, and what they are doing to solve them, are told elsewhere herein. Some of the cures or palliatives of these difficulties which have been adopted are described at length. These articles can hardly fail to furnish valuable suggestions to any city engineers or other paving officials whom traffic difficulties are bothering or threatening.

Public Work for the Unemployed

In many sections of the United States there is just now a somewhat greater degree of unemployment than during the past four or five years. Some assert that this is due to a catching up of production, others that it is only a temporary slack time between seasonal activities. Whatever the cause, the remedy most generally proposed is the speeding up of public works.

This is not a new idea; it has been proposed many times. Within certain limits it is practicable, and offers at least a partial solution to the problem. States, counties and cities have money, or are able to raise it cheaply even during periods when money is scarce. In most political units a greater or less amount of public work is necessary or desirable for providing better transport facilities, better health protection, or increased service along other lines. In many cases it is possible to move up the program of public work without increasing costs or creating difficulties in construction.

It is not desirable, however, to attempt to carry on construction activities under unfavorable conditions of climate or weather. The cost or quality of road construction, for instance, is influenced materially by temperature, rain, and subgrade condi-

tions; and increased cost due to unfavorable conditions and to greater risk on the part of the contractor may be greater than direct relief measures to the unemployed would entail.

The field of public improvements is a very large one; and the industries which engage in it are peculiarly fortunate in that public work provides for them a steady and growing market, year in and year out, little affected by hard times, but nevertheless having a reserve capacity which may be called into use when other fields of work are dwindling.

By all means, let us begin as soon as possible such increased activity in public improvements as is possible without sacrificing quality of work or greatly increasing its cost, in order to help the unemployed ordinarily engaged in other lines of work. Preparing and delivering stone, sand and other materials to be used in work planned for next spring, grading and other excavating, may come under this head.

Recognition for Federal Engineers

The successful operations of the Public Health Service are dependent upon the quality and training of its personnel, and these factors, in turn, are directly influenced by permanency of appointment. The sanitary engineers of the Service now, as in past years, operate on a Civil Service status. This arrangement provides an artificial discrimination between the engineers and the regularly commissioned medical officers, which is not warranted by present-day conditions, and which reacts to the disadvantage of the engineers and places them generally in an inferior position.

A bill is now before Congress to remedy this situation, and it is to be hoped that it will pass. It also affects the technical and scientific personnel now serving under the same handicaps as the engineers. The time is past when doctors, or any other group, have a monopoly of public health work. But the most important barrier to full participation by engineers in this work is the refusal of the engineers themselves to go beyond the narrow sphere of training given them at college, and their reluctance to accept responsibility in a wider field.

This charge can not lie against the engineers of the Public Health Service, however. They are an exceptional group, in training, in ability, and in loyalty; and they deserve the rewards provided by the proposed bill, small as they are.

Pavement Guarantees

The question was asked: "Do you require contractor's guarantee on pavements? For how long a period?" Of the 453 replies received, 116 do not require a guarantee and 337 do.

Of the latter, 164 require a 5-year guarantee, 9 on asphalt only.

A one-year guarantee is required by 61 cities; 3-year by 44; 2-year by 27; 4-year by 8. Ten years and 1½ years are asked by one city each.

Quite a number vary the length of guarantee with the kind of pavement. Asphalt 5 years and concrete 1 year are asked by three cities; asphalt 5 years and brick 1 year by four cities; asphalt 5 years and granite block 9 months by one; asphalt 5 and macadam 1 by one city; asphalt 5 years and concrete and brick 2 by nine cities. Bituminous 3 and concrete 1 by two cities. Two require 5-year for sheet asphalt and asphalt concrete, and 3-year for brick, stone and reinforced concrete. One asks a 5-year for sheet asphalt and concrete and 3-year for brick; another a 5-year for sheet asphalt and a 3-year for brick and concrete. One asks a 6-year for asphalt block, 5-year for asphalt, and 1-year for concrete, granite and bituminous macadam. One asks 4-year for brick on 4-inch concrete base and 5-year if on a thicker base.

Others, without giving particulars, report 6 months to 5 years; 1 to 5 years; 3 to 5 years; 4 to 5 years; and 5 to 10 years.

Three-year guarantees are the common practice in Indiana; 4 years are required by state law in Iowa. Some states declare guarantees illegal.

A Substitute for Taxes

There can be only occasional unimportant exceptions to the general rule that you cannot get something for nothing, and when it is stated that the town of Fairhope, Alabama, has no taxes, it is evident that there must be some substitute therefor, since the community maintains a school and a water system, owns its own wharf, has a library, an auditorium and other public buildings. As a matter of fact, this town of about 4,000 population owns every foot of land within its borders and individual property holders merely lease their holdings and pay an annual rental therefor. It is the money from these annual rentals which supports the community and thus these are in reality taxes, although the term "rental" is not so obnoxious to some, and the promise of "no taxes" may attract some to settle there.

Garbage Collection in Summit

In Summit, N. J., garbage and ashes are collected from the cellars, rather than from the sidewalk or the back door as is the practice in most cities. The town has a population of about 12,000, and eight men are employed to collect garbage and eight for ashes. Each man is responsible for satisfactory service on his particular route.

Because of the time required to remove the ashes and garbage from the cellar, and also because heavy trucks might do damage to the private driveways in driving back to the cellar doors, horses and carts are used for collection, although trucks were formerly used for the purpose.

The garbage collected is taken to an incinerator, while the ashes are used for making fills in various parts of the town.

City Sells Plumbing Fixtures

The city of Marfa, Texas, has just completed a new water and sewerage system. When constructing the latter, the sewer connections were laid up to the curb line so as to avoid tearing up the streets later. The city also decided that, as there is a large

percentage of Mexican laborers in its population, a good health insurance would consist in aiding these small house-holders in getting their houses sewered. Consequently the city bought a carload of plumbing fixtures which are being sold to the Mexicans on the installment plan.

Traffic Troubles in Various Cities

How a number of cities are attempting to solve problems of narrow streets, sharp curb curves, street layout, parking spaces and others

"What are your principal problems of street layout and design which result from increasing traffic? What are you doing toward solving these problems?"

These two questions were included in a questionnaire sent to all city engineers a few weeks ago, for it was thought they referred to problems which, in many cities, are the most serious ones confronting the city engineer. About half of the cities reporting gave definite replies naming their problems.

About ten percent stated that they had no such problems ("none yet" said some); most of these because they were small, had wide streets, or were not on main routes of travel. Vinita, Okla., with 80-foot to 100-foot streets, and Astoria, Ore., with 40-foot to 44-foot roadways, are among the second.

The most common problems were those due to narrow roadways, sharp curb intersections, and lack of parking space. Narrowness was reported by 145 cities; lack of sufficient parking space by 53 cities; and too short radii at curb intersections by 41 cities. These three are inter-related, especially narrowness of roadways and parking troubles.

Several cities found the narrowness of roadways especially troublesome at intersections, where traffic accumulated during "stops" required by traffic regulations. Others reported parking problems serious only or chiefly on streets carrying street railway tracks.

These problems are solved, of course, by widening roadways where possible, rebuilding curb intersections with longer radii, and providing parking space, where these are financially possible or the councils or voters can be convinced of their desirability. Replies to the second question varied from a despondent "What *can* we do?" to an elated "Are simply doing it."

SOLVING THE NARROW ROADWAY PROBLEM

In California, Glendale has widened several major streets and expects to widen others and open and extend some this year. Oxnard is widening to 90 ft. and 80 ft. respectively two that connect with a new state highway. Palo Alto is widening important streets under a comprehensive plan. Pasadena is widening, opening and extending streets. Santa Paula is preparing for street opening and widening, the land for which will cost $100,000.

In Colorado, Greeley is widening to the standard of the Chicago Regional Zoning Commission, 56 ft. to 76 ft.

In Connecticut, Bristol is using tree borders for the roadway. Manchester is widening and cutting back corners. Stamford is establishing wider street lines for future development.

In Florida, St. Augustine is paving narrow streets from property line to property line; the sidewalks, if any, to be provided by the property owners.

In Illinois, Clinton's problem has been relieved by state building 18-ft. concrete road through the residence section to divert through traffic from the business section.

Leavenworth, Kansas and Uniontown, Pa., are widening intersections.

In Maine, Portland is narrowing its sidewalks.

In Massachusetts, Adams and Greenfield are setting back curbs. New Bedford is replacing cobble gutters with penetration macadam.

In Michigan, Niles is widening as described in a special article in this issue.

In Missouri, Independence is setting curbs back 4 to 6 feet on each side.

In New York, Amsterdam is securing 30-ft. roadways in residence streets. Binghamton and Geneva are widening intersections. Norwich, Rochester and Syracuse have widened the main streets. Tarrytown has established two miles of set-back lines.

In Ohio, Lakewood is widening pavements on side streets for parking and confining parking to these streets. New Boston has voted $230,000 for widening. Warren is flaring the width of cross streets near main thorofares.

In Oklahoma, Ponca City reports 50 percent of its work is street widening.

In Pennsylvania, Luzerne has widened Main street 15 feet on each side. Monessen is widening to 50 or 60 feet. Wilkinsburg is widening by moving buildings.

In South Dakota, Aberdeen is widening the paving on secondary streets.

In Texas, Amarillo is widening as in Niles, Mich. Houston is securing 100-foot right of way for the main street.

In Wisconsin, Lacrosse is making new pavements 36 ft. wide. Milwaukee is widening roadways on car line streets to a minimum of 50 ft., the right-of-way being obtained by gift if possible, otherwise by purchase or condemnation. Oshkosh is planning wider streets, and set-back lines for business and manufacturing districts.

Reports of widening, without details, were given by other cities as follows: Arkansas 1; Colorado 1; Florida 1; Illinois 5; Indiana 2; Iowa 2; Kansas 3; Massachusetts 2; Michigan 6; Mississippi 1; New Jersey 2; New York 6; North Carolina 2; North Dakota 2; Ohio 7; Pennsylvania 5; Texas 2; Virginia 2; and Wisconsin 5.

LONGER CORNER RADII

Many cities are relieving congestion at intersections by flattening the curves at curb intersections. The lengths of radii reported for the new curves are: Americus, Ga., 12 ft.; Venice, Ill., 20 ft. or more; Brainerd, Minn., 15 to 30 ft.; Crosby, Minn., 15 and 20 ft.; Columbus, Mo., 20 to 40 ft.; Albuquerque,

N. M., up to 35 ft.; Massillon, O., 16 ft.; Wooster, O., 20 to 25 ft.; Enid, Okla., 25 to 40 ft.; New Brighton, Pa., 10 ft.; Hoquiam, Wash., 20 to 25 ft.; Fond du Lac, Wis., 20 ft.

Lengthening of radii without specifying length of new is reported by the following numbers of cities: Connecticut 1; Florida 1; Idaho 1; Illinois 3; Indiana 3; Iowa 2; Kansas 2; Massachusetts 4; Michigan 2; Minnesota 1; New Jersey 2; New York 9; North Carolina 1; North Dakota 1; Ohio 5; Oklahoma 1; Pennsylvania 7; South Dakota 1; Virginia 1; West Virginia 1; Wisconsin 1.

SOLVING PARKING PROBLEMS

Solutions of the parking problem may be divided under two heads—providing new space for parking, and regulating the use of existing spaces.

Under the former, San Mateo is grading vacant lots for free parking. Bristol, Conn., is offering city-owned spaces for parking. Creston, Ia., offers free parking on rented ground. In Augusta, Me., private property is used for parking. Bangor, Pa., provides municipal parking space. Denton, Tex., is paving streets in the rear of business houses for parking. Puyallup, Wash., is opening vacant lots for parking. Beloit, Wis., is providing free public parking near the business district.

Limiting parking time to one hour in the business district is reported by San Mateo, Calif.; La Porte, Ind.; New Ulm, Minn.; Muskogee, Okla.; and La Crosse, Wis. Two-hour parking for rural trade by Newton, Kans.

Limiting the parking period, time not given, was reported by Glendale and Napa, Calif.; Benton, Ill.; Huntington, Ind.; Davenport and Fort Dodge, Ia.; Coffeyville, Kans.; Rochester, Minn.; Helena, Mont.; Norfolk, Neb.; Allentown, Harrisburg, Pa.; Charleston, S. C.; Charlottesville, Va.; and Walla Walla, Wash.

"Regulating" or "restricting" parking: Blytheville and Prescott, Ark.; Fresno, Calif.; Manchester, Conn.; Leavenworth, Kans.; Stillwater, Minn.; Independence and St. Joseph , Mo.; Corsicana, Tex.; Kenosha, Wis.

Parallel parking is used in Napa, Calif., and Greeley, Colo.; while San Mateo has changed from parallel to 45° parking.

Parking is permitted on one side of the streets only in Middletown, Conn.; while in Hattiesburg, Miss., and Charleston, S. C., one-side parking is permitted on some streets and no parking in others. Parking is permitted off side streets only in Bangor, Pa., and Clarksville, Tenn. Double parking is prohibited in Helena, Mont., and all parking in Fairmont, W. Va. De Kalb, Ill., endeavors to keep parking nearer the curbs.

OTHER SOLUTIONS

Making some narrow streets one-way streets is reported by Norwich, Conn.; Augusta, Me.; Hattiesburg, Miss.; Auburn, N. Y.; Tarrytown, N. Y., Altoona and Wilkinsburg, Pa.; Knoxville, Tenn.; Staunton, Va.; Fairmont, W. Va.

A number of cities find that poor pavements, especially weak foundations, are a cause of traffic trouble. As remedies, Berkeley and Richmond, Calif., put a rock cushion under pavements on adobe soil. Alton, Ill., aims at smoother pavements. Pine Bluff, Ark., and Kokomo, Ind., are using thicker foundations. Seymour is getting better foundations by using better materials and drainage; Canton, Miss., by drainage. Binghamton and Elmira, N. Y., are using heavier bases, and Niagara Falls, N. Y., an 8 in. concrete base. Elyria, Sandusky and Marietta, O., are using heavier bases, and Lima both greater thickness and more reinforcement. Altoona, Pa., is using 8 in. reinforced pavements instead of 7 in., and 8 in. bases instead of 6 in. Jeannette, Pa., uses 12 in. telford base. Midland, Pa., is laying brick on concrete instead of gravel. Grafton and Moundsville, W. Va., are laying heavier pavements. Oshkosh, Wis., is laying heavier and better drained foundations and waterproof surfaces.

Golden, Colo., is relaying disintegrating asphalt concrete. Lebanon, Pa., is paving gravel streets. Davenport, Ia., is eliminating valley gutters. Albuquerque, N. M., is flattening high crowns. Amsterdam, N. Y., is resurfacing. Tonawanda, N. Y., is reconstructing 35-year old brick pavements. Utica is designing each pavement for its estimated future traffic. Wooster, O., treats dirt streets with gravel or cinders and blades regularly. Coatesville, Pa., is replacing black-top surface (which is "washboarding") with concrete. Meadville, Pa., finds cold patches failing and is using rock asphalt for patching, and replacing with brick. West View, Pa., is laying concrete pavements with rich top course, mesh reinforcement, wider center joints and better planned intersections. Chippewa Falls, Wis., is doing away with raised cross-walks.

In the matter of street layout, Sterling, Bristol, and Middletown, Conn., Grand Rapids and Pontiac, Mich., Vancouver, Wash., and Clarksburg, W. Va., are opening new streets. Miami, Fla., Durham, N. C., and Canton, O., are cutting off the corners at staggered or offset intersections. Miami is installing traffic circles and safety isles. Lexington, Ky., is constructing a new street parallel to the Federal highway from the center of town. Barnstable and Haverhill, Mass., and Dallas, Tex., are straightening streets; and Houston, Tex., is reducing curves to 6° or less.

Ann Arbor, Mich., is by-passing highways around the city, and the state is to build a by-pass highway around New Brunswick, N. J. Stillwater, Minn., is designing arterial streets. Oswego, N. Y., and Winston-Salem, N. C., are paving streets parallel to congested ones. Thomasville, Ga., is opening new and wider streets. Grand Forks, N. D., has created a new through street. Diverting traffic from congested streets is reported by several.

Experts to study traffic have been employed by Bridgeport, Conn., Tulsa, Okla., Knoxville, Tenn., and committees have been appointed by Newburyport, Mass., and Jamestown and Schenectady, N. Y. Boulevard stops are employed in Fairfield, Ala., Visalia, Calif.; Longmont, Colo.; Americus, Ga.; Lewiston, Ida.; Fort Dodge, Ia.; Stillwater, Minn.; Lynchburg and Salem, Va.; Anacortes, Wash.

A number of cities report relying upon traffic signs, stop-and-go signals, etc. Jennings, La., is removing mushroom lights to facilitate traffic.

Helena, Mont., reports abandoning its street car system to facilitate traffic, and Watertown, N. Y., substituting buses for cars.

Highway Practices in the Eastern States

Absracts of papers read at the Fourth Annual Convention of the Association of Highway Officials of the North Atlantic States

Detours and Maintenance of Traffic During Construction

Abstract of Paper by John A. MacDonald, State Highway Commissioner of Connecticut

Since highways are becoming lanes of communication and a means of distribution of raw materials, manufactured products and foodstuffs, any interruption of a constant flow of traffic is serious. To ignore traffic requirements endangers popular support. Nor can we solve our problems by restriction or by placing the burden on someone else. Any restriction of traffic, while it may seem, at the time, an advantage, is really an admission of failure in the end.

In Connecticut, during 1927, there were maintained 170 miles of detour on 120 contracts, involving a total expenditure for oiling, posting, lighting, and general maintenance of $129,069.15; and the construction work placed that year totalled 205 miles of highway involving about $7,000,000 expenditure. The expenditure for proper maintenance of detours is insignificant compared with the expenditure for construction.

A plan for traffic control during the work should be as much a part of the plans for the improvement as the profile or cross-section. Time spent in planning reduces the field problem. New construction, however, rarely presents much of a problem; reconstruction does.

There are 4 methods of handling traffic during construction: 1. The one-way traffic plans, by which all traffic is passed through using telephone or flags or both; 2. Detouring all traffic, and closing construction work absolutely; 3. A combination of these two; 4. Let traffic take care of itself.

The last should never be used. The others are applicable, alone, or in combination; often as conditions vary the method of handling traffic will vary. In selecting the method, the type of highway, amount of traffic, the width of the road under construction, the season of the year, the length of the detour, the safety features of the detour and the type of traffic are all factors.

With cement concrete, it is feasible to build one-half the roadway at once, allowing traffic to use the other half. This is not the case with water-bound macadam or penetration roads. Heavy grading work usually makes it impossible to guarantee a safe and constant passage. The amount of traffic, both local and through, may govern. For instance, if it is necessary to handle a large local traffic, through traffic can probably be cared for by the same plan.

When a 2 or 3-lane road is being built there is generally ample opportunity to pass traffic, which may not be the case with a narrow road. During the spring or wet season, narrow and slippery country roads should not be used. In long jobs, delays are apt to irritate travelers, and trucks or horse-drawn vehicles slow down the line greatly. It is generally better to require traffic to travel longer distances than to hold it for one-way traffic for any length of time. Passenger cars and small trucks can be handled on detours much more readily than can large trucks or buses.

If one-way traffic is maintained, the subgrade must be kept smooth and serviceable. Proper barricades must be provided and obstructions in the highway carefully signed and lighted at night. Patrols should be provided.

Safe and serviceable surfaces should be maintained on the detour, the bridges strengthened, holes filled and stones removed. If it is to be used in dry weather, a dust preventive should be applied; if in wet weather, adequate drainage. Brush should be cut at dangerous corners to afford a view, signs maintained for direction and safety; and these signs should be placed with especial reference to use after dark. Colored lanterns may be used to advantage.

The detour should be maintained continuously until after construction work has been completed, and when no longer used, it should be put back into condition at least as good as the original.

Bus lines often offer a serious problem, since they are required to serve a certain route, and rerouting is often impossible without damage to their business and injury to their patrons.

Highway Design

Abstract of Paper by Harold Giffin, Field Engineer, New Jersey State Highway Department

The outstanding tendency in the use of all motor vehicles today is greatly increased speed of operation. This is a gain to the public if there is not a corresponding decrease in safety. Probably higher operating speeds will come. This places upon the designer the burden of adapting highways to greater speed. The need is emphasized for more road space, the elimination of road hazards and limiting of obstacles to the maintenance of higher speeds.

The importance of highways in the general scheme of transportation is indicated by the phenomenal increase in the use of interstate passenger buses following the opening of the Delaware river bridge at Camden. This has decreased the revenues of the main railroad feeding the adjacent New Jersey territory more than $1,000,000 in a single year. Undoubtedly the improved service offered by buses, and the consequent great increase in their use, requires the highway engineer to note their increasing tendency to occupy a large portion of the roadway. If these units could be kept moving, the problem would be simpler, but they stop to take on and discharge passengers, occupying much roadway

to the detriment and inconvenience of other highway users.

The most important feature of highway design is alignment. Each section of highway is a separate problem, and its solution depends largely upon the amount of money available. One of the important features to be considered is sight distance. For passing another vehicle, a sight distance of about 800 feet is desirable, though less may answer in many cases without bad results. Less than 400 feet does not allow passing without a hazard. An extra traffic lane should be added where the sight distance is less than 500 feet. If this cannot be done a traffic line or other warning should be built into or painted on the pavement. But it is better to spend money in making the roadway safe and adequate than to be too generous with warnings. The vertical sight distance should be somewhat longer than the horizontal; 600 feet is little enough for a two-lane road.

Banking on curves has been much discussed. Disadvantages include an invitation to speed, and the possibility of ice formation; and it would seem that banking is both unnecessary and unwise.

Grade is generally more a problem of location than of design. Heavy cuts and fills are sometimes unavoidable, but indiscriminate cutting off of tops and filling of low places is not to be encouraged. It is well to keep the grade as nearly as possible close to the natural surface of the ground. Rise and fall should be considered. Grades at intersections require careful treatment. Abutting owners have the right to reasonable access, and a moral right to a grade suitable to the conditions of the property.

Shoulders should not invite traffic, but should serve in an emergency. They should be firm and usable at all times, and wide enough to provide for a parked car.

The New Jersey Highway Commission is not authorized to build sidewalks, but sidewalk space is always provided and the grading often done, in hope that local officials will complete the work. The designer should assume that in the near future sidewalks will be built along many parts of the road, and plan accordingly.

Corner breaks and transverse cracks are not yet entirely solved. The thickness of pavement and the amount and spacing of reinforcement are still uncertain, as is the proper placing of dowel-bars. The binding of slabs, due to poor alignment of dowels, is probably a cause of some tranverse cracks and spalling at the joints. The economy of reinforcement is still debatable.

The modern concrete road does not need more than a 1-inch crown in a 10-cent slab. Since vehicles do not travel closer to the curb than three feet, this strip can be used for parking and to carry water. It should not be included as part of the lanes of travel, but in addition to the width required for traffic.

The paved width should allow 10 feet for each lane of traffic and 8 feet for a parking lane.

Three-lane roads create a hazard in that the three lanes are really used by four lines of traffic. Widening to four lanes on curves, both horizontal and vertical, improves them.

Usual intersections limit the combined capacity of two roads to that of the greater. Additional pavement width at the intersection helps; longer radii at turns help to clear the turning traffic. We are rapidly approaching the point where special types of intersection—circles, divided intersections, and separations with and without ramps, will be used. Certain tendencies in regulating traffic must be noted by the designer. First is that of allowing a right-hand turn on a red light. Second is allowing left turns on green light from the center of the road without passing around the center of the intersection.

The danger of spending too little on improved features of design is greater than that of spending too much. Attention should be paid to the aesthetic side, too. Beauty is demanded in many engineering structures and the public is willing to pay for it.

Highway Maintenance

Abstract of Paper by L. D. Brownell, Division Engineer, Department of Public Works, New York State

The New York State plan of maintenance consists of a maintenance deputy through whose office all maintenance and repair work is handled. The state is divided into nine districts, with a district engineer in charge of each. Each district includes five to seven counties with 1,000 to 1,200 miles of completed highway to maintain. Through the district office is handled not only the maintenance work of the district, but also the construction and reconstruction surveys, the preparation of plans for highway improvements, and other engineering work. The Legislature appropriates maintenance money by counties, in accordance with a budget prepared by the department, and after this appropriation has once been made it must be spent in the county for which it was appropriated, or not at all.

Each district engineer has an assistant who devotes all his time to maintenance problems of the district. Each county is in charge of an assistant engineer, designated by the district engineer and located at some central point in the county. Some of the larger counties are divided into two districts, with an engineer in charge of each. The average mileage covered is 150 miles. Each county is divided into patrol sections of from 15 to 20 miles, depending upon the type, condition and location. A patrol foreman with a 1-ton truck is located in each section. He has two to four helpers. These work directly under the county assistant. Each county also has one or more general foremen with gangs of ten to fifteen men and one or two 3-ton trucks. These have rollers and other necessary tools to undertake reconstruction work. In addition, there are trucks assigned to each district which may be transferred as needed.

Of the 10,208 miles in the State Highway System, 5,976 miles, or 59%, are waterbound macadam (2,107) or penetration macadam (3,869). These require surface treatment. On waterbound macadam, a protecting mat is laid, using the least possible bituminous material, generally 0.2 to 0.25 gallon per sq. yd.—in no case more than 0.3 gal. It is planned to treat waterbound macadam once

in two or three years, and penetration once every five to seven years.

Roads to be surfaced are selected in September or October of the preceding year. As soon as selected, cover material is delivered in stock piles. Clean stone chips that will pass a ¾-inch circular screen and be retained on a ⅜-inch circular or ¼-inch square screen are used. Local materials are used sometimes, but infrequently. Practice calls for 12 to 20 pounds of cover per square yard of pavement. It is not considered desirable to use larger sizes of stone which will require rolling, except where a rough surface is desired, in which case standard No. 2 stone combined with No. 1 is used. Rolling is necessary here, and adds to the cost.

All surface treatment is completed before June 1. It is done almost invariably by department forces. The first step is patching and repairing holes and raveled places, after which the surface is cleaned by brooming or other means. Cut-back material is usually used for patching, being mixed in a small portable concrete mixer at the roadside. Central mixers have been used in some locations. The use of these reduces inconvenience to traffic, which is important.

A rigid schedule is maintained on this work, the men working overtime if necessary. As soon as the oil has been spread, the cover is placed, using mechanical spreaders attached to the rear of dump trucks. While this work is going on, cautionary signs are placed. Oil is applied to but one side of the road, and time for this to dry is allowed before the other side is oiled. Cover material is stored in large stock piles and handled by the mechanical spreader, rather than in small piles, dangerously located along the right of way.

Concrete Road Maintenance

Abstract of Paper by A. W. Muir, Superintendent of Maintenance, New Jersey State Highway Department

Material for filling joints and cracks must be easy to handle and low in cost, while being able to withstand both high and low temperatures. It should be placed firmly and closely. The crack or joint must be cleaned, which may be done by an air jet; it must be dry, or a tight joint is difficult, especially if placed hot. On wide cracks an admixture of mineral substance to the tar or asphalt is desirable. A mixture of slate dust, of which 95 per cent will pass a 300 sieve, and asphalt cement with a penetration of 85 to 100, in proportions of 80 to 90 per cent of asphalt, has been found excellent.

In patching broken-down areas and cuts, all broken or cracked concrete should be removed and the edges be squared up. If the pavement is reinforced, sufficient reinforcement should be exposed to permit tying in new rods or mesh. In case of a public service opening the area of concrete removed should be 6 to 12 inches wider all around than the area excavated in order to get a firm foundation for the edges of the patch. In case of a broken-down area, it is desirable to undercut the edge of the old pavement at least 6 inches to permit placing a toe of new concrete under the edge of the old slab. The edges of the old slab must be thoroughly cleaned and wet, and pointed with thin neat grout immediately before pouring begins. Where high early strength is desired, a rich mix should be used, as 1:1:2, and a 2 per cent admixture of calcium chloride, as solution, is of much assistance. The amount of mixing water should be very low, not exceeding 4½ gallons per bag of cement, and the mixing time should be increased to 5 minutes. The concrete should be placed in thin layers and tamped thoroughly. By use of low water ratio, long mixing time, and calcium chloride, patches have been opened to traffic in twenty-four hours.

Surface treatment is desirable where there is considerable spalling or shelling off of the surface finish. In applying this, deeply shelled areas should first be patched in order to bring the surface to a reasonable contour. Both tar and asphalt are used for the surface coat. About 2 to 3 gallons per square yard are applied, after which the cover material is placed. Sand is considered too fine for the surface coat. Dustless screenings, which are commercially termed ½-inch stone, are generally used.

Bituminous resurfacing is of two classes—the thin resurfacing and the ordinary bituminous pavement. The latter is of the usual sheet asphalt or asphaltic concrete surface. The former consists of a paint coat of asphaltic cement and about a half inch of asphaltic concrete. Natural rock asphalt has been used with success in this work. Amiesite and a 1¼-inch asphalt block have given satisfaction.

Resurfacing with concrete, which is a recent development, shows much promise. Broken-down areas are first patched and the concrete resurface placed. The minimum center thickness on the Syracuse test road was 2¾ inches, and the maximum 4 inches. The edge thickness varied from 3½ to 5 inches. In Connecticut, some of this work has been done, but a greater thickness has been used, the minimum being 5 inches.

Conditions Affecting Traffic Efficiency

Abstract of Paper by Charles MacDonald, County Engineer, Westchester County, New York

As highways become better, traffic becomes greater. Improvements afford relief, but such improvements attract traffic and again cause congestion. Congestion causes delays which cost money. Worcester, Mass., estimates a daily loss of $35,000 because of delays in through traffic. Cincinnati, a daily loss of $100,000; Chicago, twice as much in the loop; and New York loses a million dollars daily through traffic delays.

Because old roads are often laid out poorly, as compared to modern practice, changes in location must be made; but because communities have grown up along these roads, the acquisition of land for relocation is costly. Planning is necessary to include development of alternate new routes on less costly land, and to select most advantageous routes.

By greater visibility, straight alignment permits greater speed with safety, and safer passing of cars. If curves are required, they should be of

long radius, and banked. On grades of appreciable length, widening is justified.

Increase beyond 40 feet in width does not bring adequate returns. If more capacity is required, an alternate relief route should be provided. Where traffic is heavy, and it is physically possible to do so, grade crossings should be eliminated. At intersections, it is sometimes desirable to increase pavement widths, giving greater visibility and permitting doubling of traffic lines when held up by cross traffic. Upon signal to proceed, these double lines soon work back to the normal single line, and have a much quicker get-away. Cutting back curb corners to give a radius of 15 to 20 feet is beneficial.

In the use of pavements, the "middle of the road" driver is a cause of serious loss of traffic efficiency. Such a driver prevents other cars from passing, and is also a menace to oncoming traffic. Educational work by traffic officers patrolling the roads is of value. Generally the educational work should be begun on the traffic officer, since few of them appreciate this side of their task.

Lane marking, the road being divided into zones ten feet wide, and markers placed at intervals of 2,000 feet showing a bold "Drive to the Right" have been tried in Westchester County with apparently good results. These lane markings apparently increase the efficiency of the road 50 to 60 per cent. A 30-foot pavement divided 6-9-9-6 is better than when divided into three 10-foot lanes.

Parking seriously cuts down the value of a road. In cities, municipal parking places should be provided. In rural sections, shoulders 6 to 10 feet wide provide parking space, and later may be used for foundation for wider pavements.

Traffic lights have not been a cure-all. They have been installed in many places where they are not needed. Some action should be taken to limit their installation. The handling of traffic is today more than ever an engineering problem and should be guided by engineering recommendations after an adequate study of requirements. Automatic traffic lights may be used where intersecting traffic is somewhat equal in volume, and at certain periods of the day or week. Flashing or pulsating lights may be of greater value in warning rather than stopping traffic. Signals should be uniform, and traffic ordinances also. Boulevard stop systems have been of value in many places.

Since traffic cannot be maintained efficiently without a full cooperation of both design and regulation, it would seem that the highway official must soon assume responsibility for both design and construction of highways to carry traffic, and their use after construction.

Bridge and Grade Crossing Problems

Abstract of Paper by H. O. Schermerhorn, Engineer of Bridges and Grade Crossings, Department of Public Works, New York

The control of the bridge situation now rests with the State. The problem is a tremendous one and cannot be accomplished in a limited period of time. One policy adopted calls for the reconstruction each year of all bridges located upon highways scheduled that year for construction or reconstruction. This permits a relocation, with improved alignments and grades. In addition, the most dangerous of the existing structures, to the limit of the money available, are rebuilt. In such cases, the new bridge is located for proper alignment, and new approaches are built as necessary.

Curvature is kept away from bridge heads as far as possible. It is the aim of the department to secure a minimum sight distance of 300 to 400 feet.

Standard types selected include flat concrete slabs for spans up to 24 feet, with concrete T or I beams from 25 to 45 feet inclusive. From 45 to 100 feet, plate girders are used, while for over 100 feet there are standard through trusses, as well as a pony truss between 80 and 125 feet. Reinforced concrete arches are used to a limited extent, and rigid-frame reinforced concrete structures are being provided. Deck types are preferred where headroom will permit because of future easier widening. Bridge foundations, due to the wide variation of conditions, cannot be standardized. No matter how small the bridge, a sub-soil investigation is made before the design is prepared, including wash drilling, and cores when needed. All loadings are in accordance with specifications of the American Association of State Highway officials. On main highways, Class A loading is used, which is a 20-ton truck followed and preceded by 15-ton trucks on each traffic lane. On second and third class roads, this is reduced to a 15-ton truck followed and preceded by 10-ton trucks. On short-span bridges for two lanes of traffic, minimum width is 26 feet between curbs, or 28 feet between parapets. This is reduced to 24 feet on bridges of 45 to 100 feet span, and to 22 feet on spans over 100 feet. When three-lane and four-lane structures are built, a width of 10 feet is provided for each lane regardless of the length. A portal clearance of 15 feet is provided on through bridges, and 14 feet on all overhead construction.

On all bridges, reinforced concrete pavement is used, separated from the remainder of the floor system. Approaches have a uniform thickness of eight inches of concrete, though waterbound macadam is sometimes used temporarily. Sidewalks are elevated eight inches, which, with modern cars, is about the maximum safe height of curb.

Every grade crossing problem requires special consideration. No definite and fixed rules can be promulgated to apply in all cases, but certain requirements are followed. Approach grades are limited to six per cent. The normal minimum width of roadway between curbs on overhead bridges is 30 feet. Minimum overhead clearances in underpasses is 14 feet. Minimum sight distance is 300 feet; minimum radius of curvature on approaches is 800 feet, with 1,000 feet preferred; minimum widths of shoulder outside of pavement is seven feet, and five feet is allowed between the edge of pavement and guard rail. All pavement is widened on curves. A vertical curve is not used over the structure as a change in grade curve, but vertical curves on the approaches with a normal camber on the bridge is the aim. This allows future reduction in approach grades without changing the pavement on the structure.

Recent Legal Decisions

STATUTORY METHOD OF CONDEMNATION OF LAND FOR STREETS EXCLUSIVE

A municipal corporation which has complied with South Carolina Civil Code §4500, giving municipalities power to condemn land for streets, and providing the method of determining the value of the land and assessing the damages caused by the opening of the street, has full power to condemn land for such purpose. The remedy is exclusive.—Evans v. Town of Edgefield, South Carolina Supreme Court, 137 S. E. 208.

NEW CONTRACT FOR PAVING AT INCREASED RATE WITHIN COUNCIL'S DISCRETION

The Pennsylvania Supreme Court, City of Allentown v. Heyman, 289 Pa. 28, affirms 85 Pa. Superior Ct. 210, and holds that the application of the foot front rule in the assessment for sheet paving does not require the whole of the work to be done under one contract. Different sections of the improvement made under difficult contracts at different unit prices may result in different assessments per linear foot in the different sections separately improved.

The cancelling of a paving contract and the entering into a new one is in the discretion of the council, which has sole charge of the method of doing the work and the time at which it should be done. In this case the original paving was interrupted first by sewer construction and then by federal restrictions due to the World War. After a period of four years a new contract was entered into with the same contractor at an increased rate per square yard. It was held that the increase in cost, due to the advance in the price of materials and labor was not a matter for which the municipality could be held responsible, in the absence of a showing of improper exercise of discretion by the council.

CITY NOT LIABLE FOR FAILURE TO REPAIR STREETS TAKEN OVER BY STATE

Illinois Acts 1919, section 22, as amended in 1923, gives the state highway commission the absolute power to take over certain streets inside of cities and towns and improve them without consulting the municipal authorities. When an improved city street is so taken over and made a part of the state highway system, the city is relieved of responsibility for a failure to repair it.—Gardner v. City of Covington, Illinois Supreme Court, 156 N. E. 830.

CORRECTION OF ENGINEER'S PAVING ESTIMATE BEFORE LETTING CONTRACT

The Kansas Supreme Court holds, Gulick v. City of Cherryvale, 122 Kan. 210, 251 Pac. 399, that a city of the second class, in letting a paving contract, does not act without authority nor in violation of law in permitting its engineer to raise his estimate of the cost before the contract is made where that is done to correct an error in the estimate.

There is no Kansas statute requiring cities of the second class to advertise for bids or let street improvement contracts to the lowest bidder.—Same case, 252 Pac. 905.

BONDS FOR GENERAL PURPOSES DO NOT INCLUDE PAVING BONDS

The Kansas Supreme Court holds, Keplinger v. Kansas City, 251 Pac. 413, that the phrase "for general purposes" in the act providing that bonds for utilities, such as waterworks, shall not be taken into account in determining the limit of the city's power to issue bonds for "general purposes," refers to bonds which are a charge against the taxpayers generally as distinguished from bonds for improvements the cost of which is charged to the property specially benefited. Therefore, in determining whether the limit for the issuance of paving bonds has been reached, waterworks bonds are to be counted.

CITY CANNOT, AFTER BEGINNING WORK, CHANGE ITS PLAN OF ASSESSMENT UNDER MISSISSIPPI STATUTE

Under Mississippi Laws 1912, c. 260, where a city begins to pave its streets at the public expense without assessing benefits to the abutting owners, it cannot proceed, adverse to the property owner and against his wishes, to pave the street and assess a portion of the cost as special improvement against his property.

Where abutting owners petition the city to pave a street on specifically named conditions as to the cost and charges against them, the city must, to charge the abutting property with the cost, accept the propositions as made. Unless its orders conform to the conditions in the petition, it cannot maintain a suit to charge the property with a portion of the cost on the theory of contract or of estoppel.—City of Cantor v. Davis, Mississippi Supreme Court, 111 So. 137.

ZONING ORDINANCE RESTRICTING USE OF SMALL LOTS FOR BUSINESS PURPOSES HELD UNREASONABLE

The New York Appellate Division holds, Oppenheimer v. Kraus, 223 N. Y. Supp. 467, that a zoning resolution prohibiting the use for business purposes, of a structure with a width of less than 20 feet and a depth of less than 50 feet, is arbitrary and unreasonable, and the enforcement thereof would deprive owners of their property without due process of law.

ABBUTTING OWNER HELD NOT ASSESSABLE ON PROPERTY SEPARATED FROM PAVED STREET BY UNPAVED CITY PROPERTY

A paving plan was changed so to leave a large portion of ground, triangular in shape, between the paved roadway and the property of an abutting owner. The owner admitted his liability for a special assessment on the part of his property directly abutting on the paved street, but contended that this portion of ground constituted a park or plaza, which was owned by the city, and to the extent that it

abutted the newly paved street the city, and not he, should pay for the improvement. The city urged that the triangle constituted a neutral ground merely, and that to all intents and purposes the owner's property actually fronted on the paved roadway. The Louisiana Supreme Court held, Jacob v. Mayor, etc., of New Iberia, 163 La. 416, 112 So. 30, that the strip was the property of the city, which could use or dispose of it in any lawful manner, that it injured rather than benefited the owner's property, by making ingress and egress more difficult, and that the owner was not liable for the assessment.

LIABILITY OF UNNECESSARY DESTRUCTION OF SHADE TREES IN GRADING STREETS

For unnecessary injury as a result of the manner in which public work is constructed a municipal corporation, acting in its governmental capacity, is liable to the same extent as a private person or corporation. Applying this principle, the Tennessee Supreme Court holds, Lebanon v. Dillard, 295 S. W. 60, that where it appeared that the removal and destruction of shade trees by the agents of a city were incidental to the paving and grading of the street on which the residence of the owner fronted, but there was some evidence that the destruction of the trees was a negligent and unnecessary injury, the remedy provided by the statute, Shannon's Code, § 1988, for the recovery of damages for property taken or damaged by municipalities by grading of streets, was not exclusive.

STREET IMPROVEMENT ORDINANCE HELD NOT SUBJECT TO REFERENDUM STATUTE

The Kansas statute on the subject provides that when it is necessary to improve a street, the governing body of a city shall by resolution declare the work necessary, and in the absence of a sufficient protest within 20 days, it shall have power to cause the improvement to be made. It must do this by the more formal method of passing an ordinance, and not merely by resolution. The Kansas Supreme Court holds, State v. City of Kingman, 254 Pac. 397, that such an ordinance is not subject to the operation of the statute authorizing a referendum in the case of ordinances generally. The city commission may not be under a legal duty to go on with the improvement it has declared necessary, but by the very words of the statute it has the power to do so.

ACCEPTANCE OF GRADING AND PAVING HELD BINDING ON OWNERS ALTHOUGH PRIOR PROCEEDING IRREGULAR

Where there was a substantial compliance with the city charter in the proceedings for grading and paving a street and the city council in good faith accepted the work as being in accordance with the contract, the Oregon Supreme Court held, Austin v. Tillamook City, 254 Pac. 819, that such acceptance was binding on the property owners. The plaintiff in an action to quiet title to lots which had been sold for failure to pay paving assessments did not show that his assessment was increased by any error in establishing the grade of the streets or in any of the proceedings. It was held that the proceedings could not be collaterally attacked after the improvement had been made, upon the ground that some of the prior proceedings were merely irregular.

SUFFICIENCY OF PAVING RESOLUTION

A paving resolution providing that the street should be "paved with sheet asphlat, asphaltic concrete, or bitulithic pavement" was held to state "the general character of the materials to be used" as required by the Alabama statute, Code 1923, sec. 2176. A resolution providing for pavement with "asphaltic concrete, sheet asphalt, bitulithic paving, vitrified brick, or Portland cement paving," was also held sufficient under the statute.—Stovall v. City of Jasper, Alabama Supreme Court, 110 So. 317.

REMOVAL OF SHADE TREES FROM CENTRE OF SIDEWALK

The Alabama Court of Appeals holds, City of Fairfield v. Lewis, 112 So. 98, that in the discharge of its duty to maintain public sidewalks in a reasonably safe condition for their appropriate use, a municipality has power to remove trees growing in or near the centre of a sidewalk and impeding pedestrians, and neither the city nor the city authorities could be held liable in damages for so doing. The rights of an abutting owner under section 235 of the state constitution, providing for just compensation for property taken for public use, were held not involved in an action for damages for the destruction of such trees.

VENDOR'S LIEN HELD PRIOR TO MECHANICS' LIEN CONTRACT FOR PAVING

The Texas Commission of Appeals holds, Texas Bitulithic Co. v. Warwick, 293 S. W. 160, that a mechanic's lien contract for the cost of paving a street creates a lien on homestead as to a lot described as bounded by the street line where the deed to the owner does not expressly or impliedly declare that he shall have no rights in the sidewalk and street in front of the property. But a vendor's lien is prior to the paving lien. The court said: "As we view it, the paving companies can protect themselves against prior liens. Before paving in front of any home, they can ascertain the lien indebtedness already against the property, and, if they think the value of the home insufficient to protect both liens, they need not do the paving."

CITY HELD ENTITLED TO RECOVER FROM CONTRACTOR AMOUNT OF JUDGMENT FOR INJURY TO PEDESTRIAN CAUSED BY CONTRACTOR'S NEGLIGENCE

A pedestrian was injured by tripping over a water pipe laid across a sidewalk by a building contractor. The Washington Supreme Court holds, City of Cle Elum v. Yeaman, 259 Pac. 35, that the city, as well as the contractor, was liable where it was chargeable with notice of the condition, but, if recovery were had against the city, it could recover the amount thereof from the contractor as the original wrong-doer without any statute or charter so declaring, simply because as between the contractor and the city, his was the active negligence and primary liability. They were not joint-tortfeasors, between whom there is no contribution.

NEWS OF THE SOCIETIES

March 23-24—NEW JERSEY SEWAGE WORKS ASS'N. Trenton, N. J. John R. Downes, Secretary, Bound Brook, N. J.

April 17-19 — SOUTHEASTERN WATER AND LIGHT ASS'N. Atlanta, Ga. W. F. Stieglitz., Secy., Columbus, S. C.

June 11-16 — AMERICAN WATER WORKS ASS'N. Annual meeting at San Francisco, Calif.

June 25-29—AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting at Atlantic City, N. J.

Oct. 22-26—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention at Detroit, Mich.

ASSOCIATION OF HIGHWAY OFFICIALS OF THE NORTH ATLANTIC STATES

The fourth annual convention of the association was held at Atlantic City, N. J., February 15-17. The registered attendance was about 1,800, but a total of about 2,500 attended the sessions. The sessions began with an opening address by President C. D. Buck, chief engineer of the Delaware Highway Department, which was followed by an address of welcome by Gen. H. L. Scott, in behalf of Gov. A. Harry Moore. Ralph Harcourt welcomed the convention to Atlantic City in behalf of Mayor Ruffu.

The papers presented at the meeting appear in abstract on another page. For the most part, these were excellent, covering late practice in the highway field. The discussion by Geo. E. Beggs, of Princeton University, of "Concrete Bridge Design and Checking Stresses Graphically" was of especial interest and value.

The officers of the association, who were recently elected, are: President, C. D. Buck, chief engineer, Delaware State Highway Department; vice-president, F. E. Everett, Commissioner of Highways, New Hampshire; secretary and treasurer, A. Lee Grover, Secretary of State Highway Commission of New Jersey. The Board of Directors are: L. D. Barrows, Maine; F. E. Everett, New Hampshire; Stoddard B. Bates, Vermont; John A. Mac Donald and Gustave Okefelt, Connecticut; G. H. Henderson, Rhode Island; A. W. Brandt and R. B. Traver, New York; W. G. Sloan and A. Lee Grover, New Jersey; Jas. P. Steuart, Pennsylvania; C. D. Buck, Delaware.

AMERICAN WATERWORKS ASSOCIATION

The Nominating Committee has selected the following nominees for the various offices to be filled at the San Francisco Convention for 1928-29. In case no other independent nominations are filed, as provided for in the Constitution, the report of the Nominating Committee will be considered as an election.

For president: William W. Brush, Chief Engineer, Department of Water Supply, Gas and Electricity, 2456 Municipal Bldg., New York, N. Y.; for vice-president: Jack J. Hinman, Jr., Associate Professor of Sanitation, University of Iowa, Iowa City, Ia.; for treasurer: George C. Gensheimer, Secretary, Commissioners of Water Works, Erie, Penna.; for trustee, District No. 1: C. D. Brown, Manager, the Walkerville Water Company, Walkerville, Ont., Canada; for trustee, District No. 2: Stephen H. Taylor, Superintendent Water Works, 312 Municipal Bldg., New Bedford, Mass.; for trustee, District No. 6: John Chambers, Chief Engineer and Superintendent, Louisville Water Co., Louisville, Ky.

Circulars giving complete details of the convention, which will be held during the week of June 11, at San Francisco, will be sent out in the near future. These will cover the convention, the itinerary and the cost of transportation. Hotel Fairmount will be convention headquarters.

AMERICAN WATERWORKS ASSOCIATION, INDIANA SECTION

The 21st annual meeting of the Indiana Section, A. W. W. A., will be held at Purdue University, March 15 and 16. This meeting is primarily for operators and those closely connected with water plant matters. The program is being arranged by an operator of long experience, who has the interest of the operator and his problems at heart. Every opportunity will be given to present your problems and to have opinions expressed in open meeting where discussion may be had in detail. This is to be a meeting where the troublesome matters confronting the actual operator will be the feature of the day. C. K. Calvert, Indianapolis, Ind., is secretary.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS

At the annual meeting of this association, which was held in Detroit, Mich., officers were elected as follows: President, Theodore Eichorn, superintendent, department of streets and public improvements, Erie, Pa.; vice-presidents, Robert B. Brooks, director of streets and sewers, St. Louis, Mo.; Elmer C. Goodwin, examining engineer, department of street cleaning, New York, N. Y.; A. B. Cook, chief sanitary inspector, Charlotte, N. C.; treasurer, P. J. Hurtgen, director of public works, Kenosha, Wis. A. M. Anderson, 10 South La Salle St., Chicago, was re-elected secretary.

COLORADO SOCIETY OF ENGINEERS

At the annual meeting held at Denver, Colo., Jan. 21, the following officers were elected: President, O. T. Reedy; vice-president, John E. Field; secretary-treasurer, C. M. Lightburn; directors, W. R. Hellyer, C. A. Betts, R. J. O'Rourke, W. B. Freeman, John Burgess, Robert Follansbee and George M. Bull.

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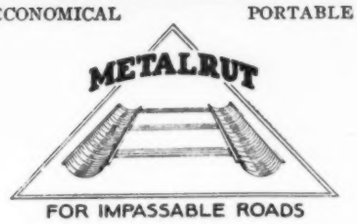

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THE CHEMISTRY OF WATER AND SEWAGE TREATMENT

By ARTHUR M. BUSWELL
Chief, Illinois State Water Survey, Professor of Sanitary Chemistry, University of Illinois.

This book presents as completely as possible the information available covering the chemical reactions taking place in the various processes by means of which water is improved for domestic and industrial use and waste liquors are rendered fit to be discharged into water courses.

Chapter Headings Include

WATER: Colloids—Chemical Composition of Waters—Economic Disadvantages of Unsuitable Waters — Industrial Water Treatment—Chemistry of Coagulation—Filtration and Disinfection—Odors and Tastes.

SEWAGE: Chemical Characteristics of Sewage—Degradation of Organic Matter—Nitrogen Cycle — Sludge Digestion—Microbiology of Sludge—Reduction—Removal of Colloids—Microbiology of Colloid Removal.

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AMERICAN SOCIETY OF CIVIL ENGINEERS, NORTHEAST SECTION

At the annual meeting of the Northeastern Section, American Society of Civil Engineers, on Jan. 28th, the following officers were elected: President, S. H. Thorndike; vice-president, R. K. Hale; secretary-treasurer, C. W. Banks; members of executive committee, J. C. Chase, H. A. Gray.

MILITARY ENGINEERS, BOSTON POST

At its annual meeting on January 25th, the Boston Post, Society of American Military Engineers, elected the following officers for the ensuing year: President, Major F. E. Hanson; vice-president, Capt. J. W. Cambell; secretary-treasurer, Lieut. L. A. Armistead; directors, Brig.-Gen. J. F. Osborn, Col. S. A. Cheney, Major R. H. Burrage, Capt. H. L. Norton, Lieut. E E. Taylor.

Lieutenant Commander Paul J. Searles, U. S. N., gave an address on "What the Navy Engineers Do."

PERSONALS

Earle Talbot has been elected a vice-president of the Hackensack Water Co. Mr. Talbot, who is a graduate in hydraulic engineering of Stanford University, 1902, has been secretary and treasurer of the company since 1915.

H. J. Harder, city engineer of Paterson, N. J., from 1900 to 1925, and since that time in charge of the special grade crossing elimination work, to which he was assigned at his own request, has been reappointed city engineer, succeeding William Gavin Taylor.

William Gavin Taylor and G. W. Knight have formed an association under the firm name of Taylor & Knight to practice consulting engineering.

Fred C. Dunlap, 68 years old, newly appointed chief of the Philadelphia Bureau of Highways and a widely-known engineer, died of pneumonia at his home January 24. He had been in the service of the city of Philadelphia, chiefly in the Water Bureau, more than twenty years, and was in charge of the construction of two of the city's largest filtration plants.

CIVIL SERVICE EXAMINATIONS

Junior Patent Examiner.—Applications until March 10 to fill vacancies in the Patent Office at Washington. Entrance salary $1,860. Examination will be given in the optional subjects of mechanical engineering, physical and organic chemistry, chemical engineering, civil engineering, electrical engineering. French or German, or both, may be taken in conjunction with the optionals named above. Preference in appointment is being given to eligibles who attain eligibility in either, or both, of the languages, and in one of the optionals named above. Competitors will be rated on physics, technics, and mechanical drawings; and the optional subjects selected. Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or the secretary of the United States civil service board of examiners at the post office or customhouse in any city.

INDUSTRIAL NOTES

Joseph R. Draney, for many years general sales manager of the United States Asphalt Refining Company and Eitoslag Paving Co., and one of the organizers and president of the Asphalt Association until 1925, effective January 1st, 1928, became general sales representative of the Natural Rock Asphalt Corporation, 223-224 Speed Building, Louisville, Ky., which corporation produces and markets natural rock asphalt from its properties in Edmonson County, Kentucky.

Shipments of Indiana trucks for January, 1928, showed an increase of 60% over January, 1927. This is on top of an increase of 29.5% for December, 1927, over December a year ago. Reports received by the Indiana Truck Corporation, Marion, Indiana, from its factory branches and many of its distributors over the country indicate that the first quarter of 1928 will break all previous records for Indiana Truck sales.

J. M. Page, formerly state highway engineer of Oklahoma, has been appointed to represent the Everlasting Paint and Sales Co., Inc., Los Angeles, Calif., in Texas and Oklahoma.

Caterpillar Tractor Co., San Leandro, Calif., has announced price reductions on Caterpillar tractors which range from 8% to over 11% and represent a cut of $400 in the price of the largest size of the "Caterpillar" tractor to a reduction of $175 in the price of the smallest model, the 2-ton.

Sullivan Machinery Company, Chicago, Ill., will be represented at the Western Road and Equipment Exposition, at Los Angeles, March 7-11, by display of its portable compressors and compressed air equipment for the road builder and contractor and for municipal and state highway and street departments. The Sullivan exhibit will be found in booth No. 239, among other manufacturers whose accounts are handled by Brown Bevis Co., distributors, at Los Angeles.

The 26th annual four-day meeting of the Pittsburgh Equitable Meter Company district managers was held recently. These annual meetings are held with the men so that they will be in a better position to serve their customers in the most efficient way, know what improvements are being made and learn about any new products. The meeting closed with the annual banquet which is attended by all department heads of the production departments as well as the office and sales department.

Joseph B. Shaw, who was formerly deputy city engineer of Utica, has been appointed district engineer of the Eastern Paving Brick Manufacturers' Association with headquarters at Utica, New York. Mr. Shaw is a graduate of Union College, and has been connected with the State Highway Department of New York and the City Engineering Department of Schenectady, and during the war was on the technical staff of the War Department, and later with the Bureau of Standards.

Walter F. Faber, former general manager of the Fort Pitt Construction Company, Pittsburgh, has been appointed field engineer of the Western District of the Eastern Paving Brick Manufacturers' Association with headquarters at Pittsburgh. Mr. Faber since 1920 has been engaged in the construction of highways as general manager of the Fort Pitt Construction Company.

Frank A. Peck, vice-president of the Universal Crane Company and of the Thew Shovel Company, was recently elected a director of the Manufacturers' Division of the American Road Builders' Association in recognition of his work and cooperation in contributing to the success of the 1928 Cleveland Road Show.

The New York City Fire Department has just put into service a fleet of 20 FWD fire trucks. These trucks, which are equipped with 6-cylinder motors, were chosen after rigid tests covering speed, hill-climbing and other important qualities.

Joseph S. Mitchell, head of the Diamond Drill Department of the Sullivan machinery Co., Chicago, Ill., died Dec. 22.

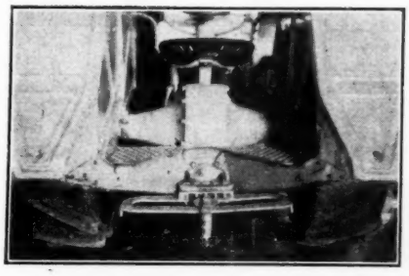
Daniel Kennedy, president of the Kennedy Valve Manufacturing Company, died at Hot Springs, Ark., on Jan. 14th, after a short illness. Mr. Kennedy, who was in his eightieth year, came to America from Ireland as a youth of seventeen. He had the distinction of originating and for half a century guiding the destinies of a firm that is today recognized internationally as a pioneer and leading builder in the valve, fire hydrant and pipe fittings field. The firm was established in a very small shop in New York City. The business grew to occupy a four-story building and by 1890, greater manufacturing facilities were required and the plant was moved to Coxsackie, N. Y. The firm was then incorporated and the name changed from Daniel Kennedy to the Kennedy Valve Mfg. Co. Continued rapid expansion required a second move in 1907, at which time the present large modern plant occupying 20 acres was built in Elmira, N. Y. Many of the veteran employees moved their families to Elmira in order to continue with the firm. In 1921, an additional 15-acre plant nearby was acquired for independent production of the malleable-iron pipe fitting lines which were introduced at that time.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

E-Z-TURN TRACTOR HITCH

The E-Z Turn Tractor Hitch Co., Bay City, Mich., has devised a new tractor hitch which, it is claimed, makes it possible to turn in one-quarter to one-half the time and in a fraction of the space. It eliminates skidding, and side-draft, it is said, and makes possible working and handling of the tractor in very close proximity to fences, ditches or other obstructions. This hitch provides a 35-inch stationary drawbar for general use. An advantage is that the implement is at all times the same distance from the tractor.



E-Z-TURN TRACTOR HITCH

ROOT HYDRAULIC SCRAPER

The Root Spring Scraper Co., Kalamazoo, Mich., has developed a new hydraulic scraper, which operates from the hydraulic pump installed on the truck. The pump installation is not changed, but a section of the pipe between the pump and the dump cylinder is cut out, and a 3-way stop cock installed. When this is closed, the body dumping device operates; a one-quarter turn closes the passage to the dump cylinder, and operates the scraper control device. A pilot valve in check is arranged so that a small volume of oil can escape into the dump cylinder, thus reducing the pressure on the blade, which is raised. This arrangement has many advantages. Quick action is provided, and ample pressure is always available; installation on the average truck is easy because there are no raising and lowering devices to install in the cab.

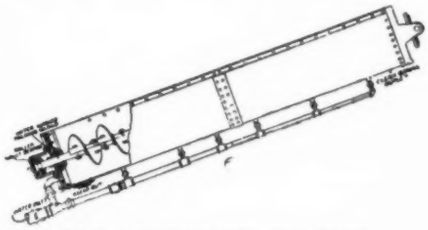
EAGLE SAND AND GRAVEL WASHERS

The Eagle Iron Works, Des Moines, Ia., manufactures Eagle sand and gravel washers which are designed to meet modern conditions due to more rigid specifications for sand and gravel. Both sand and gravel washers are made, since the gravel washer is not adapted to sand washing without changes which, in many cases, would interfere with the washing of gravel. The material is carried through an inclined steel tub, through which water flows, by a screw traveling, in the opposite direction to the water stream. The capacity depends upon the condition of the material, ranging from 25 to 40 tons per hour for the gravel washer, and 20 to 35 tons per hour for the sand washer. To drive a single washer, 7½ horsepower is required.

JOY SNOW LOADER

JOY SNOW LOADER

The Joy Manufacturing Company, Franklin, Pa., has developed a loading machine which is claimed to reduce the cost of snow removal from city streets. The working head of this machine is an exact duplicate of the device made by this company and used by the coal industry.



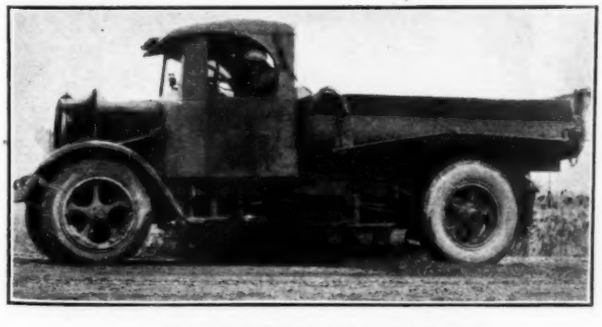
EAGLE AGGREGATE WASHER

The machine consists of two main units: A steel chassis mounted on solid rubber tired wheels, carrying a Hercules Model "G" four cylinder gasoline power unit, operative at 6 speeds forward and 2 speeds reverse, with forward speeds ranging from 74 feet per minute to 12 miles per hour, and a steel conveyor frame mounted on the chassis at adjustable angles for operation, and for low clearance when traveling, carrying the Joy patented gathering mechanism, consisting of two powerful rotating arms which sweep the material into the conveyor delivering to trucks through a swinging chute.

The Joy snow loader will handle, it is said, any kind of snow and will load from 10 to 20 cubic yards per minute. The design and construction of this unit is based upon the experience gained by the solution of widely varying mechanical loading problems.

BAKER BACKFILLER

The Baker Steel Machinery Co., Omaha, Neb., manufacture the Baker Backfiller, which attaches to a Fordson tractor. The scraper and telescopic boom are instantly detachable and the whole outfit can be loaded on the tractor and moved from job to job under its own power. The attachment does not inter-



ROOT HYDRAULIC SCRAPER

BAKER BACKFILLER AND CRANE

fere with the ordinary uses of the tractor.

The Baker Backfiller is also used as a light portable crane. Contractors find them very handy for lowering pipe into ditches, for unloading cars of pipe to truck or stock pile and similar work.

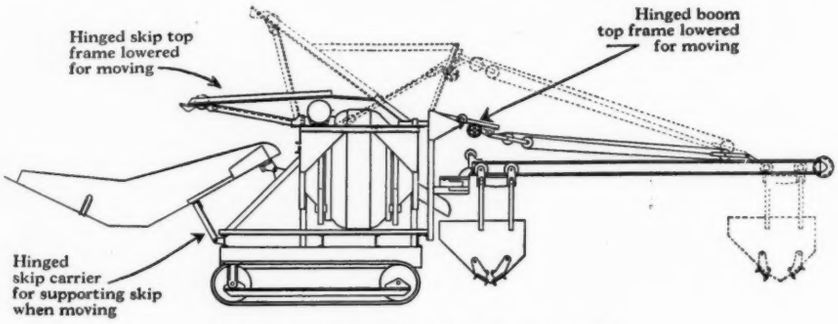
The double drum winch can be purchased separately for backfilling with boards, and for other power winch operations. The drums and shafting are mounted on roller and ball bearings. Each drum has a separate control and the clutches, especially designed for this service, are of the internal expansion type. Power is taken from the tractor and transmitted to the drum shaft through a chrome nickel worm and phosphor brone worm gear which are encased and run in an oil bath.

CLINTON CONCRETE CONVEYOR

Clinton Motors Corp., Reading, Pa., have perfected a ready-mixed concrete conveyor, which is not a mixer but a conveyor and agitator. It provides means for utilizing the advantages of the central mixing concrete plant, allowing service over a very much wider range than is possible when using ordinary dump equipment which allows settlement and separation of the aggregates. Tests made by the department of civil engineering laboratories, Columbia University, show that ready mixed concrete hauled in this conveyor for a period of 2 hours and 30 minutes showed greater strength, at both 7- and 28-day periods than concrete fresh from the mixer. A summary of the tests follows:

These results are obtained, it is said, by the peculiar design of the revolving tank, which, since it has no fins, baffle-plates, or scrapers, eliminates aeration and perfects hydration.

This equipment is available at the present time in two sizes; one unit to carry three cubic yards, the second for two cubic yards.


Hinged skip top frame lowered for moving
Hinged boom top frame lowered for moving
Hinged skip carrier for supporting skip when moving

MULTI-FOOTE MOVABLE TOP FRAME

ONE-MAN TOP FRAMES FOR MULTI-FOOTE PAVERS

The Foote Co., Nunda, N. Y., has announced as a recent improvement on its pavers, one-man top frames which can be raised or lowered in less than ten minutes by one man using the power of the hoist, thus avoiding delays due to overhead obstruction.

All of the parts of this top frame are hinged and secured by removable locking pins. Without removing the water tank, the height of the MultiFoote pavers can be reduced to 11 feet—the lowest of any paver now produced. But even this low height can be further reduced, for shipping by rail over lines having very low clearance heights, by removing the water tank. In lowering the improved top frame, it is necessary only to secure the hoist cable in the clamp provided on the backbone, remove the connecting pin in the backbone, and lower the arch frame using the hoist brake. In raising the process is just reversed. The A boom frame is raised by utilizing the weight of the skip. Stretching a light chain between the skip cable and the top of the A frame, and lowering the skip, lifts the frame up into position.

SUMMARY OF COMPRESSION TESTS

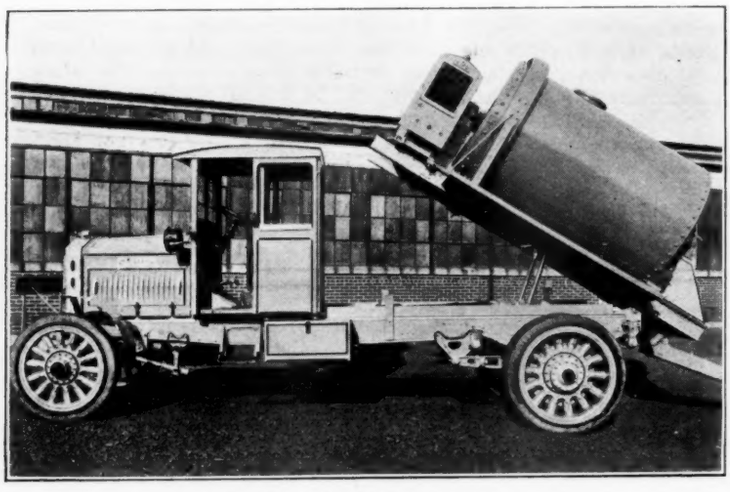
Timer after Discharge from mixer	Average compressive Strength at 7 days	Average compressive Strength at 28 days	Consistency of Mix Bottom	Top
	A Series—1:2:3.85 Mix			
4 minutes	2448	3410	2¾	...
20 minutes	2175	3340	2	1¾
35 minutes	2010	3440	1⅞	1¼
53 minutes	2085	3107	2	1⅝
1 hr. 5 minutes	2063	3117	1¼	1¼
1 hr. 42 minutes	2157	3253	¾	⅞
2 hrs. 30 minutes	2232	3433	⅛	⅛
	B Series—1:3:6 Mix			
4 minutes	765	1397	7	...
20 minutes	778	1475	7	6½
41 minutes	713	1575	7	6
57 minutes	828	1652	8	6
1 hr. 12 minutes	846	1703	6¼	6
1 hr. 42 minutes	784	1673	7¼	5½
2 hrs. 12 minutes	826	1690	6¼	5½

BITUMEN SPRAY GUN

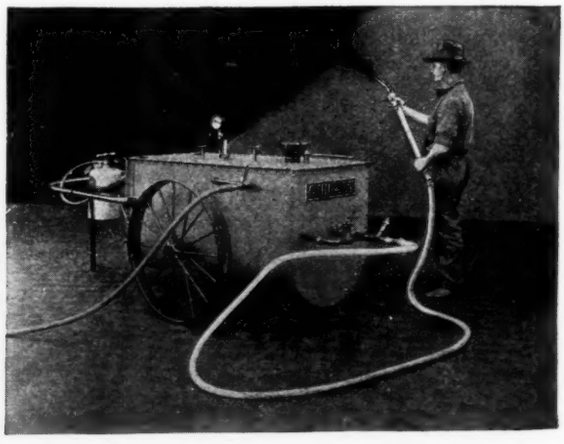
The Quigley Furnace Specialties Co., N. Y., has developed the Quigley bitumen gun, which carries the "spray" idea into a new field, making it possible to apply bituminous products as protective coatings to foundations, walls, roofs, dams, bridges, pipe lines, penstocks, etc.

Penetration and adhesion depend largely on the speed and heat of the spray. As both are under constant control, practically perfect coverage is assured, and overheating to make up for delays in reaching the job at the proper temperature is not necessary.

The savings claimed for this gun are such that it is said it will frequently pay for itself on a single job. Ability to control the temperature and thickness of coating makes compliance with the most exacting specifications easy, and permits close estimating of material and time. Compressed air is never in contact with the material in the gun, nor is it used to



CLINTON CONCRETE TRUCK



QUIGLEY SPRAY GUN FOR BITUMINOUS APPLICATIONS

NEW CATALOGS

Solar-Sturges Mfg. Co., Melrose Park Ill. A 20-page illustrated catalog describing Solar self-cleaning receptacles for waste.

Hardsocg Wonder Drill Co., Ottumwa, Ia. A 64-page illustrated catalog describing Rock Drills.

Grasselli Chemical Co., Cleveland, O. A 4-page bulletin describing results of tests in posts treated with zinc chloride.

The Heil Co., Milwaukee, Wisc. Bulletins 176 and 177 describing Heil Fuel Oil truck tanks with pump units and Heil Storage tanks.

R. U. V. Co., Inc., N. Y. A 16-page illustrated booklet on water sterilization by means of ultra-violet rays.

Erie Pump & Engine Works, Medina, N. Y. Illustrated catalogs of pumping machinery for irrigation, sewerage. water, etc., steam engines, and dredges.

Buffalo Forge Co., Buffalo, N. Y. Catalog No. 422, illustrated, 24 pages, describing Buffalo ventilating fans.

Jeffery Manufacturing Co., Columbus, O. Catalog No. 433, illustrated 48 pages, describing material handling equipment.

Trackson Co., Milwaukee, Wisc. "Trackson Tracks." 6 pages, illustrated, describes uses of the Trackson Full-Crawlers.

Atlas Lumnite Co., New York. Illustrated folder describing methods of laying safe winter concrete.

Novo Engine Co., Lansing, Mich. Illustrated folders describing Novo Roller Bearing engines and Novo hoists.

Sanitary Sewer Basin Co., Chicago, Ill. An illustrated folder describing cast iron catch basins, inlets, valve boxes and manhole frames and covers.

United Iron Works, Inc., Joplin, Mo. A 16-page illustrated catalog describing the Pomona double stroke deep well pump.

Sweet's Steel Co., Williamsport, Pa. A 72-page illustrated catalog describing rails, angles, bars, posts, tracks, and other products of the company.

Wehr Co., Milwaukee, Wisc. Illustrated catalog describing road building and industrial equipment.

Warren Brothers Co., Boston, Mass. 12-page illustrated catalog describing the Warren asphalt storage and heating tank and steam jacketed asphalt pumping system.

American Truck and Body Co., Martinsville, Va. 20-page illustrated catalog describing truck bodies for handling brick and block in bulk.

W. S. Tyler Co., Cleveland, O. 8-page illustrated folder on screening equipment; and catalog 53, 56 pages, illustrated, describing test sieves and their uses.

French & Hecht, Davenport, Iowa, and Springfield, O. An illustrated catalog of 48 pages, describing wheels for road working equipment. Most of the illustrations are from actual photographs.

Sullivan Machinery Co., Chicago, Ill. Bulletin 83-I, 16 pages, describing Sullivan "WO-6" Stationary Compressors; Bulletin 76-O, 3rd edition, 16 pages, describing the many applications of the Sullivan Electric Portable Hoist; Bulletin 74-C, 4 pages, Type GF-2 portable drill steel furnace; Bulletin 81-S, 32 pages, describing Sullivan Rotator Hammer Drills; Bulletin 83-H, 12 pages, describing 2- and 4-Cylinder Sullivan Vertical Air Compressors. Bulletin 81-O and 81-Q, Sullivan Auger Rotators Class H-8, and Rotator rock drills L-5 and L-3.

Osgood Co., Marion, O. Bulletin 2707, 16 pages, illustrated. Describes Osgood gasoline and electric excavating machine. An historical sketch, with illustrations showing shovels and draglines of 40 years ago, is interesting.

Galion Iron Works & Mfg. Co., Galion, O. Catalogs and bulletins describing McCormick-Deering E-Z Lift Motor Grader, and the Galion Cletrac, Twin City and caterpillar powered motor graders.

Linde Air Products Co., N. Y. A 28-page illustrated booklet describing methods of welding piping.

The Spirit of Service

An Advertisement of the
American Telephone and Telegraph Company

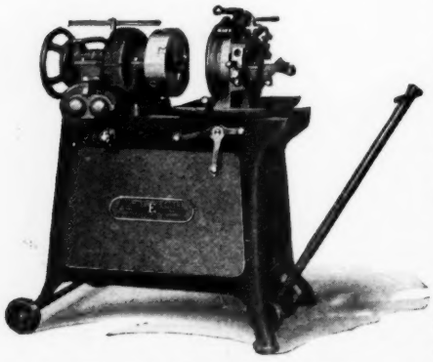
IN JULY, 1926, lightning struck the Navy Arsenal at Denmark Lake, New Jersey. The explosion demolished the $80,000,000 plant, rocked the countryside, left thousands homeless and many dead. While the community fled in terror, fresh explosions hurled fragments of shell and debris far and wide.

High upon the roster of those who responded to the call of duty were the telephone workers. Operators in the danger zone stayed at their posts. Those who had left for the day and others on vacation, on their own initiative, hurried back to help handle the unprecedented volume of calls. Linemen and repairmen braved exploding shells to restore the service. Within a little over an hour emergency telephone service was established, invaluable in caring for the victims and in mobilizing forces to fight the fire which followed.

In spite of repeated warnings of danger still threatening, no telephone worker left the affected area.

Through each of the day's twenty-four hours, the spirit of service is the heritage of the thousands of men and women who have made American telephone service synonymous with dependability. In every emergency, it is this spirit that causes Bell System employees to set aside all thought of personal comfort and safety and, voluntarily, risk their lives to "Get the message through."

form the spray. Atomization is obtained by a purely mechanical process. Air is not entrapped in the material, which retains all its original and valuable properties, required for penetration and adhesion to the surface.



PORTABLE PIPE THREADER

Fifteen cubic feet of air a minute at 60 pounds pressure is sufficient for operation. A small portable garage compressor, operated by either gasoline or electricity will answer where no air supply is available.

Long hose gives easy access to remote places and permits the location of gun and melting pot outside of buildings, or on docks. Also it eliminates the necessity of frequently moving the outfit as the work proceeds. Material is forced through the hose with a drop in temperature of not over 3 degrees for each 25 foot length. The discharge end of the nozzle can be bent at any angle so the operator can reach places otherwise inaccessible. Special nozzles will be supplied to meet special requirements. The gun is enclosed in a steel housing, mounted on wheels. Its capacity is 15 gallons, enough to cover approximately 400 square feet of surface. The gun is equally adaptable for spraying paint, whitewash, or other cold plastic aggregates or liquids.

PORTABLE POWER PIPE THREADERS

Hall-Will, Inc., Erie, Pa., manufactures portable power pipe threaders which are particularly adapted for use by water works and water departments. The Red-E-Hall has a capacity of ¼-inch to 2-inch pipe, and is claimed to cut time and labor costs 90 per cent. As a power drive for hand stocks, it will thread up to 12-inch pipe. The Hall-Will "Super-Six" threads from 1½ to 6-inch pipe, and can thread, ream and cut off with one setting. It is driven by a 5 horsepower motor, and is particularly well adapted to heavy use in waterworks departments.

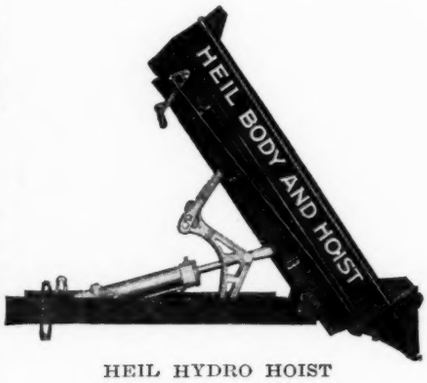
THREE-WAY DUMP BODY

The Commercial Shearing and Stamping Co., Youngstown, O., manufactures the U. S. Three-Way hoist and body which is built to fit any motor truck or trailer. This body will dump to the rear or to either side, as desired. It is made in capacities from 1½ to 15 tons. Among the advantages claimed are complete control of dumping in any position from the drivers' seat, and the ability to dump to either side on the road without adjustment. The load discharges clear of the wheels; the side gates fold downward and are wide open when the body has a 16-degree tilt.

HEIL HYDRO HOIST

The Heil Co., Milwaukee, Wis., has just brought out its new hydraulic hoist, H-2, which is built for light duty trucks of 1, 1½, and 2-ton capacities, and which provides speedy and efficient service. This device dumps a full load in 5 to 9 seconds depending on the speed of the motor. A dumping angle of 56 degrees is possible. With the standard 7-foot and 8-foot bodies the tail-gate ground clearance is 2 inches above the top of the chassis frame. The hoist and body hinges are assembled as a unit on a special subframe which comes ready to mount on a truck chassis. It is not necessary to drill any holes or refer to blueprints to install the hoist for it comes correctly mounted in its frame. Four to six U-bolts secure the dump unit to the truck chassis.

The H-2 hoist uses the same gear pump principle employed in other Heil hoists. Pivoted at the front end of the cylinder, the hoist rotates on this axis, providing a short, straight-line drive

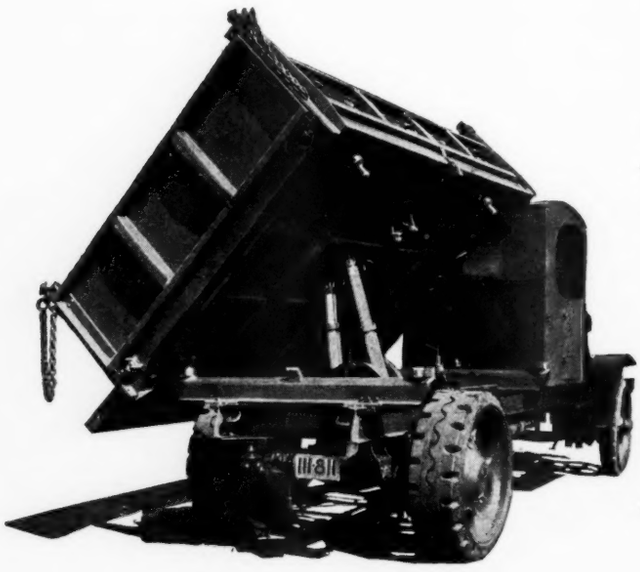


HEIL HYDRO HOIST

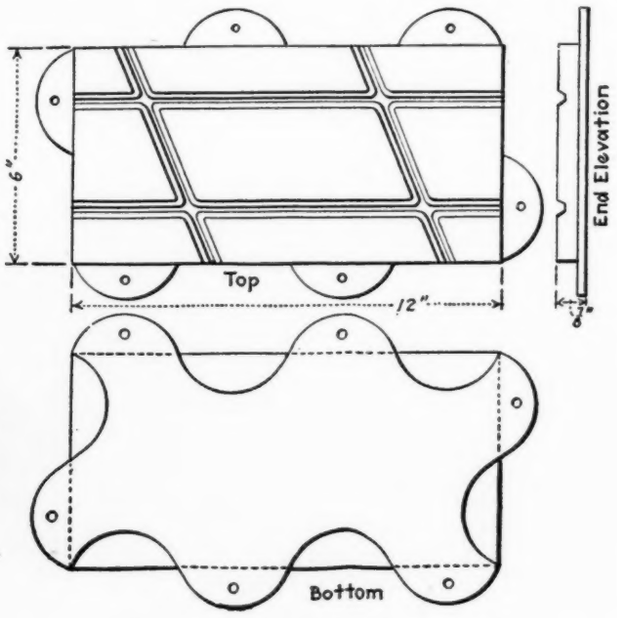
from the unit power plant to the hoist pump. There is no piping.

RUBBER SIDEWALKS AND FLOORS

Wright Rubber Products Co., Racine, Wisc., has perfected rubber blocks as a flooring for sidewalks, bridges and buildings. These are easily laid over existing wood or concrete, and, it is claimed, remain absolutely flat, without warping or curling. They are claimed to be the only block unaffected by vibration, when laid on wooden floors; and to be unaffected by extremes of heat or by moisture. Other features of value are their non-conductivity, noiselessness and ease of cleaning. They are unaffected by contraction or expansion, withstanding ranges of temperatures from 40 below zero to 110 or more above. The blocks are 6 inches by 12 inches. Each block is locked under the surface by interlap-



THREE-WAY DUMP BODY



WRIGHT RUBBER PAVING BLOCK

WATER SUPPLY . . . FIRE PROTECTION . . . SEWAGE DISPOSAL

Easier Quicker Safer

ONLY UNIVERSAL PIPE LINES are 100% cast iron. The pipe is cast iron. Its flexible machined iron-to-iron joint—an integral part of the pipe line—is cast iron. Cast iron lasts for centuries.

No hot lead, no cold lead, no lead substitutes. No pouring, no calking. No bell holes to dig. Curves laid with straight lengths. *Every joint as tight as the wall of the pipe itself.* Wrenches the only tools.

UNIVERSAL PIPE LINES STAY TIGHT . . . because the joint as well as the pipe is 100% cast iron

UNIVERSAL CAST IRON PIPE

No bell holes to dig: No joints to calk

THE CENTRAL FOUNDRY COMPANY

Subsidiary of The Universal Pipe and Radiator Company

Graybar Building, 420 Lexington Avenue

Chicago Birmingham New York Dallas San Francisco

Good News!

SERVICE BOXES WITH *STAY-ON* COVERS

No more broken covers. No more lost covers . . . Interchangeable with "Buffalo" boxes . . .

Ask for MONITOR SERVICE BOX booklet.

1001

Put your water supply, fire protection and sewage disposal problems up to our nearest office: New York, Graybar Building, Lexington Avenue at 43rd Street (adjoining Grand Central Terminal) . . . Chicago, McCormick Building . . . Birmingham, Comer Building . . . Dallas, Praetorian Building . . . San Francisco, Rialto Building

ping flaps, and is fastened by waterproof cement and concrete fastening devices. Cheapness and speed are advantages claimed in laying. These blocks have been used successfully on the Michigan Avenue bridge, Chicago. They are furnished with either plain or grooved surface.

O'CONNEL TWO-WAY DRIVE MOTOR TRUCK

BENDER INDUSTRIAL UNIT

The Bender Hoist Mfg. Co., Omaha, Neb., produces the Bender electric crane swinging boom, which is operated from two ordinary 6-volt batteries. It has a capacity of 6,000 pounds and is especially valuable in municipal uses, handling material, lumber, waterworks supplies, pipe and valves. A 2-horsepower motor with a low gear ratio, furnishes the power for this handy little unit. A cable speed with 4 lines of 4 feet per minute is maintained. Booms have a standard length of 10 feet, but can be furnished in lengths up to 20 feet. The outfit will fit any truck.

TWO-WAY DRIVE TRUCKS

The O'Connell Motor Truck Co., Chicago, Ill., makes the Two-Way Drive Super Truck, which is claimed to accomplish large savings by eliminating losses due to turning and backing. The special design of this truck enables the operator to drive forward or backward, always facing in the direction in which he is driving. Super-Trucks are made in 5-ton capacity, and are equipped with five speeds forward or backward, giving the same speed and pulling power in either direction. The construction of the front axle makes steering easy under all conditions. Foot pedals are operable from either seat position. The left foot always operates the clutch and the right the brake. A vertical steering column makes steering in either direction easy. The gear lever is shifted in the direction in which the truck is to be driven. In addition to the standard seat used on all trucks, another is mounted over the hood on which the driver sits when running backward.

KIESLER CLAM-SHELL BUCKETS

The Jos. F. Kiesler Co., Chicago, Ill., manufactures the Kiesler patent clam-shell bucket, which, it is stated, is the only claim-shell operated on the double lever arm principle. This action is responsible for the digging qualities of the Kiesler buckets, since the harder the pull, the tighter the grip at the cutting edge. These buckets, which are adapted to all types of construction and material handling, are stated to open and close with unusual speed. Full load discharge occurs when the bucket is only partially opened.

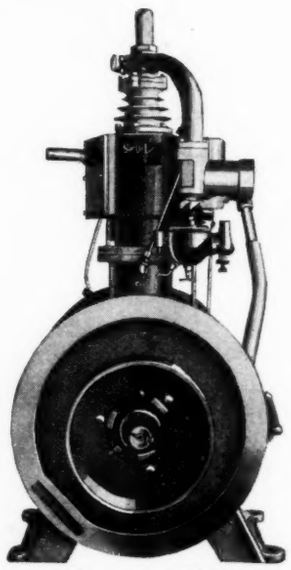
Kiesler buckets are constructed to withstand hard service. The shells cannot get out of alignment as they are doubly reinforced, and all pins in sheaves are keyed to the castings. The shape of the shell is such that material can be removed from corners sufficiently to necessitate very little hand work.

ROAD MAPS

The International Map Co., New York, N. Y., produces road maps for counties, states, and business firms. These maps may be compiled from existing data and redrawn to make them especially suitable for use by motorists; or special work may be required to chart the roads for mapping. Generally it is possible to prepare suitable maps from existing records at a considerable saving in cost. Maps may be secured in colors; folded or on sheets.

SORG OIL ENGINE

The Sorg Engine Mfg. Co., Sheffield, Ala., manufactures the Sorg Oil Engine which is claimed to be a new type of prime mover. It is an oil engine that can be made in small units without complicated pumps or auxiliary mechanism, and which weighs less per horse power than gasoline engines. Furthermore, it is said to burn non-volatile oils cleanly. It operates equally well with furnace oil, solar oil, alcohol, kerosene, or gasoline, and without adjustments. It requires no cranking, and the charge is ignited by means of an electric spark. The compression is 70 pounds per square inch, the weight of the 5 horse power unit is 260 pounds, and the speed is 800 revolutions per minute.



SORG OIL ENGINE

If you desire complete information regarding any of the appliances or equipment mentioned in this section, use this form.

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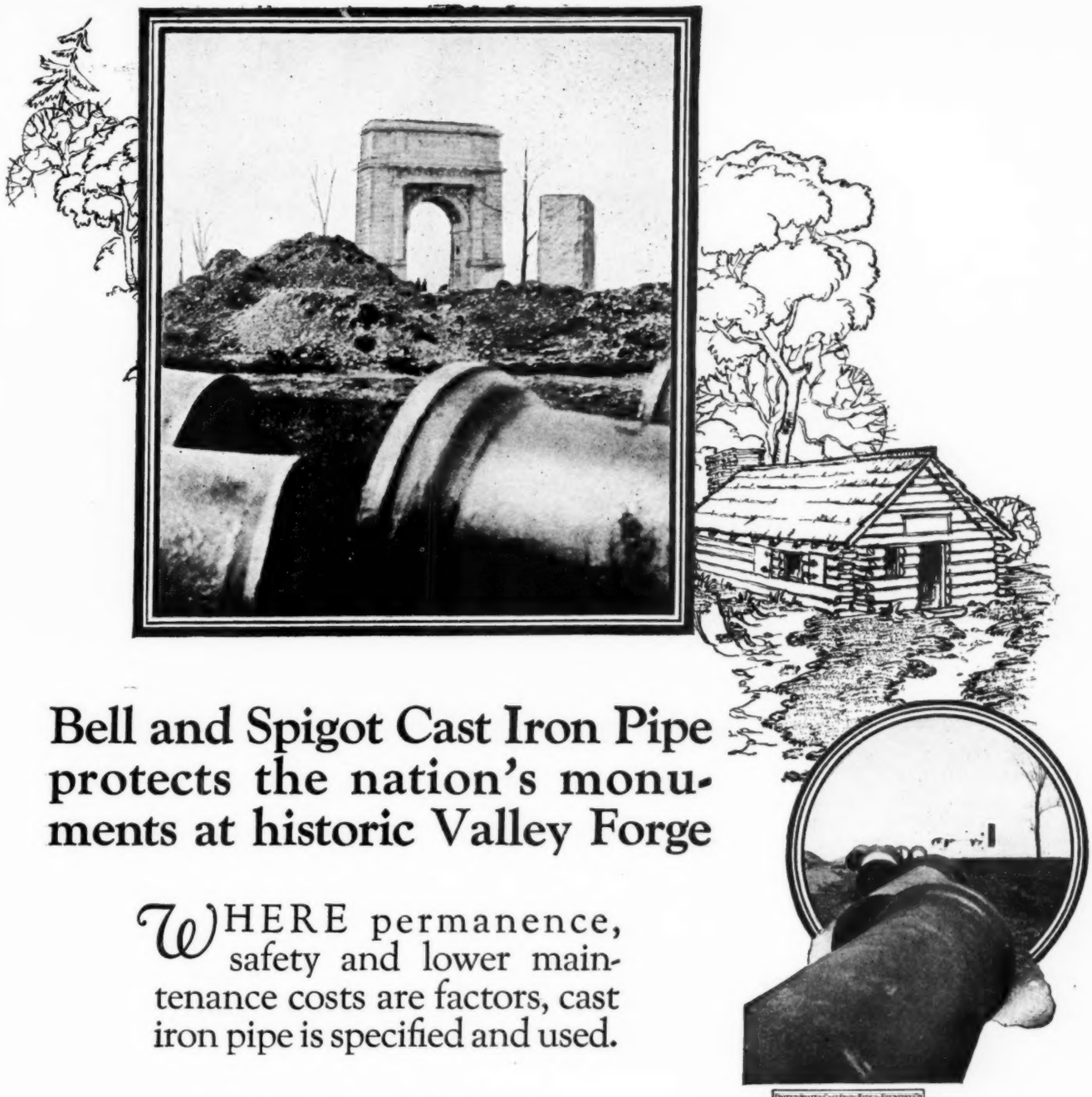

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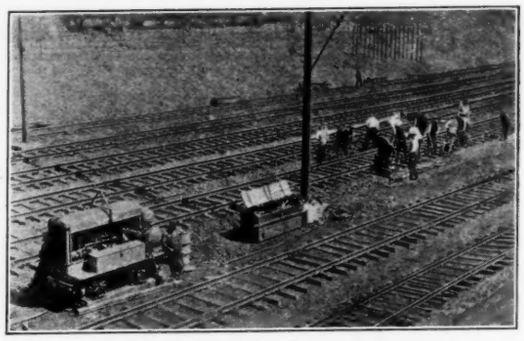
Kansas City: 13th & Locust Sts.
Minneapolis: 6th St. & Hennepin Ave.

KLAUER " SNOGO"



METALWELD RAIL CAR UNIT

SNOGO

The Klauer Mfg. Co., Dubuque, Ia., manufacture "Snogo," which is a unit especially designed for the positive and efficient removal of snow from streets and highways. This machine is made as a complete unit, and is not an attachment. It is designed solely for use as a snow remover. It is equipped with augers to cut into the snow, and a blower to remove it. A heavy-duty, low-speed engine is mounted on the rear of the main frame. Transmission is a three-unit. The first is of special design and acts as a speed reducer for both the front operating unit and the traction. The take-off from this transmisison to the blower and augers is direct and the engagement is through a Dodge, solid friction-type clutch. For traction, a standard design transmission is used, having four forward and one reverse speeds. In series with this transmission is a two-speed transmission which provides additional speed reduction and affords a travel selection of eight forward speeds. Thus it will be noted that at any traction speed the engine operation is at practically full speed and the traction requirement is negligible. As the low speed of the machine is approximately ½ mile per hour, it is appreciable that full engine speed applicable to very slow forward motion offers ample traction. As a speed of 25 miles to 30 miles an hour can be attained, when not moving snow, quick travel can be made between deeper cuts or drifts and in returning to storage or in transport to distant points for operation.

BILLE-LIGONNET ASPHALT-CEMENT BONDING PROCESS

The Asphalto-Concrete Corp., New York, N. Y., is representative of the Bille-Ligonnet process of bonding asphalt and concrete. This process is adaptable to the waterproofing of flat surfaces, including walls. Asphalt faced hollow concrete blocks are available for structural work. Asphalt faced paving blocks of concrete have been used satisfactorily in Paris. They are stated to be cheap, and the surface can be made anti-slipping by applying to the surface material suitable for this purpose.

This process is also claimed to be adaptable to the waterproofing of concrete pipe. In making this, the shell is first constructed, after which it is spun with sufficient cement mortar and stones to give the interior a rough surface, to which, when heated, the asphalt will adhere. The asphalt is introduced in a molten condition, and placed by spinning. The asphalt facing prevents leakage, even when the concrete cracks, thus allowing an extremely economical use of steel. Pipe up to 48 inches in diameter have been constructed.

It is claimed that friction is reduced, pipes do not deteriorate, and are not affected by sewer gas.

PORTABLE AIR COMPRESSORS

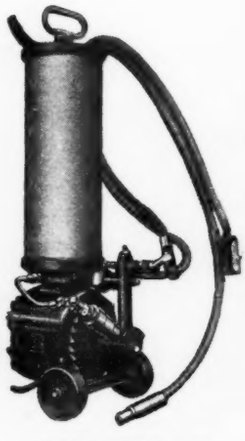
Metalweld, Inc., Philadelphia, Pa., has developed a new line of portable air compressors, in which is included a rail car mounted unit of especial value to railway maintenance engineers. It is claimed for this that force feed lubrication makes proper oiling a certainty; bevel gear drive eliminates the trouble arising from slippage; Laidlaw feather valves and counterbalanced crank shaft make the motor operate with a surprising lack of vibration; that grease-packed, ball-bearing journal boxes, cast steel accurately turned wheels, automobile type brakes, air cooled, ball-bearing clutch and electric starter combine to make a portable air compressor which can be operated and handled with an ease heretofore impossible. The simplified derailing process enables one man to complete the operation without any distortion of the frame or danger of injury to the machine.

DOT ELECTRIC LUBRICATOR

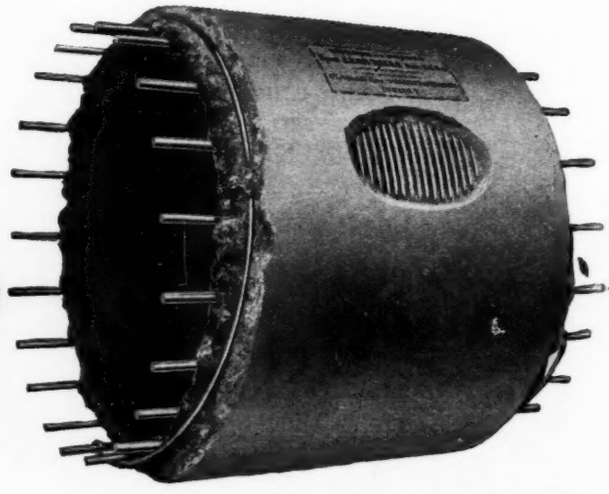
The Dot Lubrication Division of the Carr Fastener Co., Cambridge, Mass., has just brought out a new electric lubricator. It is a self-contained, motor driven unit, having a capacity of 25 pounds of grease or oil. The control of tank and motor is centered at the nozzle, making it a one-man operated tank. It is easily portable, economical, more dependable than previous types of hand-operated or air-operated lubricating tanks, and its extremely low price places its advantages within reach of the smallest user of road building machinery.

EUCLID EARTH MOVERS

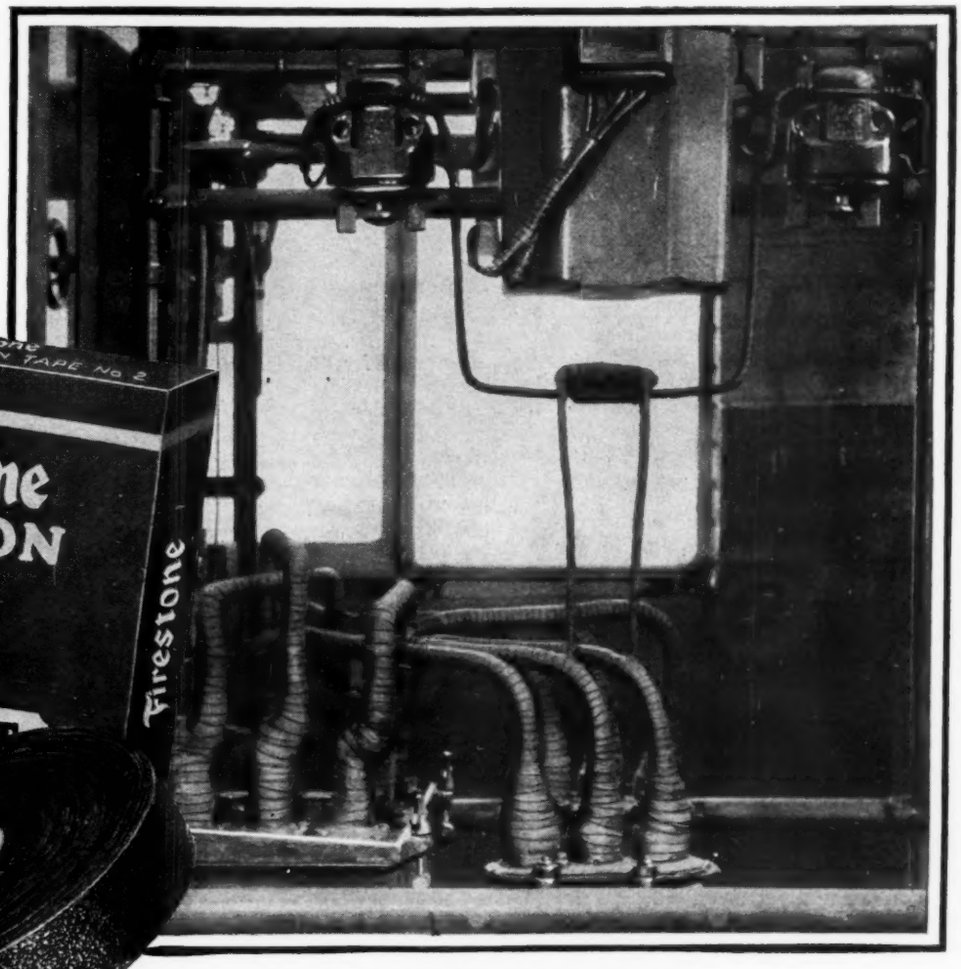
The Euclid Crane and Hoist Co., Euclid, O., manufactures a wide line of earth moving equipment, including fresnos wheel scrapers and trailers for all sizes of tractors. The fresno, built in 4-foot, 5-foot and 6-foot sizes, is a fast and economical tool for medium and short hauls and clean-up work. For larger hauls, the wheelers, built in ½, ¾, 1 and 1¼-yard capacities are better suited. The trailers of 1¾ and 2¼ yards capacity, which can be used either singly or in trains, are ideal for use with elevating graders and steam shovels.



DOT ELECTRIC LUBRICATOR



BILLE-LIGONNETT ASPHALT-CEMENT PIPE



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FRICTION TAPE

AMERICANS SHOULD PRODUCE THEIR OWN RUBBER... Harvey S. Firestone

STANDARD TRAFFIC MARKERS

Standard Traffic Marker Co., Wichita, Kans., manufactures a rubber composition traffic marker which is claimed to have many advantages. These are 7 inches high and 22 inches wide. They are securely fastened in the pavement yet they form no obstruction to traffic. When run over by vehicles, they flip back to an upright position, without danger or damage. The letters are yellow rubber inserts vulcanized into the black rubber background. The color is especially chosen for its visibility under the most severe conditions. Because of their tendency to "flip" smartly back, they will remain clear, it is stated, under snowfalls up to 16 inches in depth, and even when covered form no menace to traffic.

It is claimed they are less expensive per year to maintain than painted lines, and that they are now in use in nearly 600 communities.

LAUSON DIAPHRAGM PUMPING UNITS

John Lauson Mfg. Co., New Holstein, Wisc., manufactures a diaphragm pumping unit which is equipped to receive any of the leading makes of diaphragm pumps, or which may be ordered complete. The jack is specially designed for diaphragm use, and the working parts run in oil. The drive from the engine is through gears which are fully covered by a shield which leaves the belt pulley accessible for other work. Lauson diaphragm pumping units are furnished in two sizes—with a 2 h. p. engine for use with a 3-inch pump and a 2½ h. p. engine for a 4-inch pump. This company also manufacture a large variety of engines of various sizes. An electrically driven diaphragm pump unit is also provided.

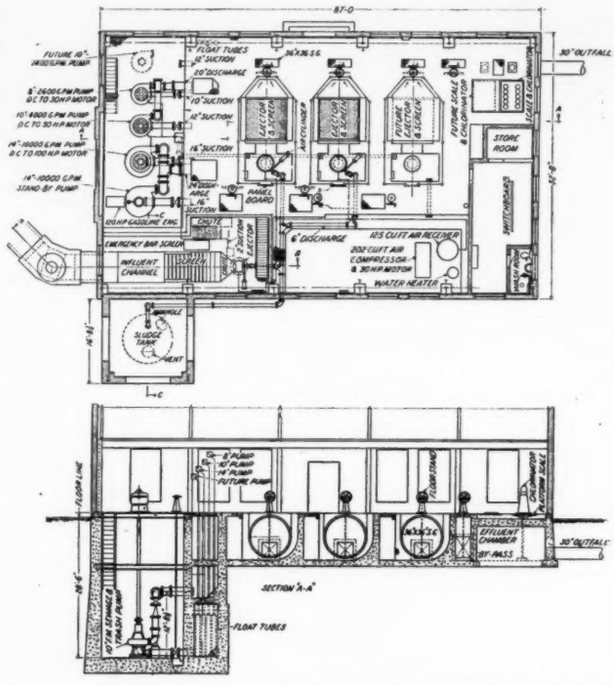
STREET FLUSHERS FOR SMALL CITIES

The Truck Equipment Corporation, Joliet, Ill., manufactures a large line of street flushers and sprinklers, both truck and tractor drawn. Among these is the Junior dual-drive street flushers, which are especially economical and suitable for cities having less than 10 miles of pavement to clean. They are made in capacities of 400 gallons for 1 to 1½-ton trucks, 600 gallons for 1½ to 2-ton trucks, and 800 gallons for 2 to 2½-ton trucks. The 400-gallon outfit will flush 1816 square yards of pavement with one tank of water, cleaning with one nozzle a trip 14 feet wide, and with two nozzles 24 feet. An experienced operator can discharge nine 400-gallon tanks per hour, eight 600-gallon tanks, and seven 800-gallon tanks.

If desired, the flushing equipment is furnished alone, and the purchaser may install it in a truck.

FARIBANKS-MORSE SEWAGE PUMP

Fairbanks, Morse & Co., Chicago, Ill., has developed a new type of closed impeller pump for the efficient pumping of raw sewage. This has two blades and two posts, with waterways having smoothed edges that will pass any materials that enter, regardless of shape or texture. Both horizontal and vertical types are provided, the essential features being the same. The blade is rounded and tapered toward the outer edge, resulting in a steep characteristic curve, which is of considerable importance in sewage work in that the extra pressure available with the rising curve will produce a flushing action, keeping the lines clear and the impeller from clogging.



FAIRBANKS, MORSE ST. PETERSBURG INSTALLATION

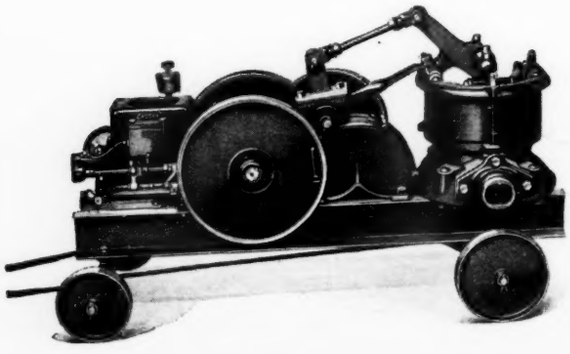
The pumping of unscreened raw sewage in many cases simplifies greatly the layout of treatment plants and this has been adopted in a number of recent installations.

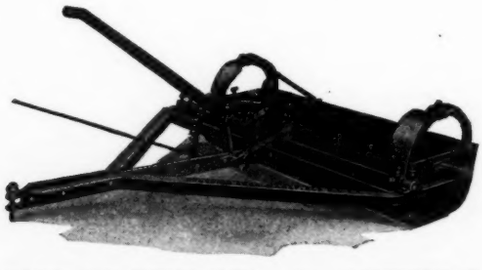
A TWO-YARD SCRAPER

The Gustav Schaefer Wagon Co., Cleveland, O., have recently added to their list of scrapers, a special "Road-Builders'" model, which has a capacity of 2 cubic yards. It was developed for use with the larger tractors and is built only to order. It weighs 4,625 pounds and has a width of 8 feet. Owing to the weight, wheels are supplied for moving from job to job. This scraper is claimed to be an efficient and cheap earth mover, especially where a large amount of earth is to be handled.

GROUNDHOG SCRAPER

The Roderick Lean Co., Mansfield, O., has developed the "groundhog" revolving tractor scraper which is claimed to be faster than other scrapers because it loads, spreads, dumps and loads again automatically without stopping or backing. Loading is controlled by a single long lever which is always within easy reach of the operator. To load, it is only necessary to raise the lever, the position of the lever determining the depth of cut. It is possible to adjust the depth of cut so as to do finishing work or to load the scraper within a few feet. When the lever is pushed down, loading stops. When ready to spread, a light pull on the trip rope dumps the load. An added advantage in close quarters, is the ability to revolve either backward or forward. It is made in 3/5 and ¾-yard capacities.





ABOVE: RODERICK LEAN CO., GROUNDHOG SCRAPER. AT LEFT: LAUSON PORTABLE PUMPING UNIT